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Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., and E. S. GREW, M.A.

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Photographs of the Canals on Mars.

READERS of "KNOWLEDGE" are mostly aware of the discussions which have from time to time arisen as to the reality of the markings on the planet Mars of the nature of fine lines, and which some suppose to be canals. It has been suggested that these, instead of being distinct lines, are but the edges between gradations of half-tones (*vide* "KNOWLEDGE," November, 1903). Another theory is that they are the effect of a number of minor detached markings and not continuous lines. If, then, a photograph could be taken sufficiently distinct to make out these markings the question could be settled definitely.

In May last the important announcement was made by Mr. Lowell that the "canals" had been actually photographed by Mr. Lampland at the Lowell Observatory, Flagstaff, Arizona. Persistent endeavours had for some time been made to secure such photographs, but great difficulties were encountered. Eventually a number of exposures were made on a continuous film with short exposures, similar to that of a cinematograph. On examination a number were found to show the canals, thus demonstrating indubitably the actual existence of the canals, or, rather, the fine lines on the surface.

Mr. Lowell has now been good enough, at our request, to send us some specimens of the actual photographs. The reproduction which we give herewith may seem somewhat disappointing, but, as may be imagined, the extreme delicacy of the lines, which, though discernible under a careful examination of the original negatives, can hardly be reproduced in an ordinary photographic print, much less in a half-tone block. This little picture will, however, give some idea of the size and nature of the plate, and beside it are reproduced the careful drawings which Mr. Lowell has made from the original photograph.

This view shows the Sinus Titanum region, and the following canals are visible in Mr. Lampland's photograph:—

Erebus	Gigas
Helicon	Laestrygon
Cerberus	Pallene
Styx	Boreas
Eunostos	Arion
Orcus	

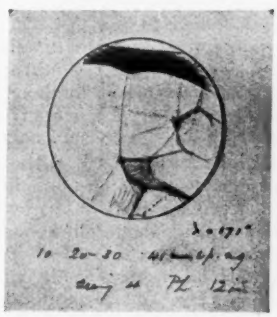
At the bottom of the right of the central point in the photograph a projecting nipple may be noticed. This was the first beginning of the new Polar Cap, and was then only thirty-six hours old.

The telescope used was a 24-inch refractor.

The planet, at the time these photographs were taken, only presented a diameter of about 15 seconds of arc, and in order to secure the necessary definition only the central portion of the 24-inch object glass of the telescope was used, a diaphragm being interposed so as to give an effective diameter of 12 inches. A colour screen allowing only the orange and yellow rays to pass was also employed.

The Lowell Observatory at Flagstaff is situated at an elevation of 7250 feet above sea level, and in a particularly clear and dry atmosphere, so that the conditions are such as can hardly be obtained at any other observatory.

Much Reduced. Reduced. Reduced.



λ = 194°
May 20,
10h. 42½-45m.
Photograph by
C. O. LAMPLAND.

λ = 171°

λ = 171°
May 22, 10h. 20-30m.

λ = 190°
May 20, 10h. 25-40m.

Drawings by PERCIVAL LOWELL.
λ = Martian meridian central at the time.

XUM

Coast Denudation in England.

By EDWARD A. MARTIN, F.G.S.

PART II.

As already pointed out, no part of the coast has suffered more greatly than where the cliffs consist of deposits of loosely-compacted sand and clay, and as scarcely any geological formations other than of tertiary and quaternary age are found in this condition, hence it is where these deposits are exposed to the sea-action that the erosion is most felt.

Probably nowhere has denudation proceeded more rapidly than on the Holderness coast of Yorkshire. Various estimates have been framed of the extent to which the coast suffers in this part, and the encroachment of the sea has been estimated at so high a figure as 30 feet, and by others at so low a one as 6¼ feet, per annum. Probably an average rate would be found in that estimated by Mr. T. Sheppard, F.G.S., for the coast between Spurn Head and Bridlington, namely, 7 feet per annum. Between these two many ancient villages have disappeared—Wilsthorpe, Auburn, Hartburn, Hyth, Cleton, Monkwell, &c.—and in some cases the names remain only as applied to modern spots which were formerly inland. Observations which have been made at Dimlington show that during the last few years the average yearly rate of erosion has been 10½ feet, and at Out Newton some ruins of an old chapel may be seen which were, in 1833, 147 yards from the edge of the cliff. South of Kilnsea, where the low boulder-clay cliffs are about 10 feet in height, the cliff dies away altogether, and were it not for the protecting groynes which have been built by the Board of Trade, erosion here would probably be considerably greater than it now is. Mr. E. R. Matthews has made some interesting calculations as to the weight and extent of the area denuded. Many estimates have been made, and these will always differ to a very great extent, depending in the first place on the assumed rate of denudation, then the average taken for the height of the cliffs, and the average weight per cubic foot of the materials constituting the glacial beds of which the cliffs are formed. The estimated weight of the deposits removed has been placed at three millions of tons per annum, whilst Mr. Matthews places the area which has disappeared since 55 B.C., the date of the Roman invasion, at 115 square miles, or nearly the equivalent to that on which London and Greater London stands. Looking at it all from a geological point of view, one must bear in mind that the sea is only now encroaching upon what formerly belonged to it. The deposits which are now suffering are accumulations of boulder-clay and glacial moraines which had no existence in tertiary times, and up till the beginning of the glacial period the coast-line ran considerably further inland than that to which the sea has even now attained. The sea at that time approached closely the line of the eastern boundary of the chalk, which runs south-west from Flamborough Head in the direction of Driffield and Beverley.

An interesting question which has puzzled observers is, What has become of all the eroded material? The silting-up of the Humber is, to a large extent, due to its deposition, together with the growth of Spurn Head; and as it is denied by some authorities that any of the silt is carried forward to the Lincolnshire coast, it would seem to follow that protective measures, if taken effectively along the whole of the Holderness coast, would go a long way towards keeping a fair-way always open in the Humber Channel.

Another portion of our eastern coast-line which is suffering at the present day, and has, indeed, suffered as long as history can record, is that which extends from the northern coast of Norfolk along the Suffolk and Essex coasts to the Thames estuary. These, again, expose to the sea cliffs of but a partially-coherent material, affording little or no protection to the battering-ram action of the waves. The deposits here formed are partly of glacial age, chalky boulder-clay being the principal material, and partly of Pliocene age (late Tertiary), the latter being known as the "crag" formation. In Essex the London Clay (Eocene Tertiary) has cropped out from beneath the crag, and this, although of a more coherent nature than the other deposits mentioned, affords but little more resistance to the eroding power of the sea. So when one leaves the chalk of the north of Norfolk we see, going southward, a gradual falling away in a south-westerly direction of the coast-line, and this only comes to an end when we reach the Thames, whilst on the south side of the estuary we find raised as a bulwark against similar denudation the uprise of the chalk. The fault which occurs in the bed of the river, and which has let down the strata on the north side to a lower level than those on the south, besides probably deciding the position of the embouchure of the river, has exposed the low-lying northern coast to the immediate action of marine denudation. Thus the whole East Anglian coast is subject to continual erosion.

A map is preserved in the Yarmouth Town Hall, copied in the time of Elizabeth from an earlier one, which purports to show the coast hereabouts as it was in the year 1000. At that date the site of what is now Yarmouth appears to have been but a sandbank across the entrance to a wide estuary, extending up to Harleston and Norwich. Considerable concern is now felt lest, by the removal of the comparatively narrow line of cliffs, a similar state of affairs may again come into existence, and the low-lying land of East Anglia become permanently flooded.

We have seen that Holderness has probably come into existence since the glacial period, and in these eastern counties again we see wide stretches of low lands intersected by broads and sluggish streams, which show to the practised eye that the period is not far away back in geological time when the sea stretched away inland, covering those parts where subsequently the boulder-clay came to be deposited. The question of erosion is a burning one, but it must be borne in mind that a considerable area was wrested from the sea in those pre-historic times, when Britain's natives witnessed the passing away of the glacier mantle which had covered so much of the country.

Although the coast of Essex has no doubt suffered much in the past, and the products of its denudation have been spread over the sea-bottom in such a way as to shallow the sea for some considerable distance from the land, modern erosion is not now so serious a matter as it must have formerly been, in view of the extensive mud flats over which the incoming tide pursues its way. But when one sees the evidences on all hands along the coast of the former existence of a much greater population than is now there to be found, there is good reason to think that many a flourishing village has been lost in the sea. The spreading out of the *débris* in the form of mud flats leads in the course of time to a contrary

movement, with a possibility of reclamation, by the building or raising of some kind of wall around areas covered at high tide. Such appears to have been done, for instance, around the mouth of the river Crouch.

Apart from the steady planing down of the coast, there is in East Anglia the additional danger of inundation. Some of the rich grazing grounds here are low-lying marshes, protected only by low cliffs. The recent fall of cliff at Pakefield, near Lowestoft, composed of boulder-clay, is but another instance of the gradual denudation of the cliffs, which, if not checked, must in the long run threaten the broadlands with inundation by the sea. There is every reason to think that before such a catastrophe could take place the protection of this portion of the coast would definitely be regarded as a national duty, and this might prove a first step towards the formation of a special Government department, having as its *raison d'être* coast protection in general.

In considering the disappearance of our cliffs we are not just now concerned with the loss of land in the pre-historic period, which was owing purely to a subsiding movement of the whole country. Of such a widespread movement we have ample evidence in the numerous submerged forests, of which traces are observable at abnormally low tides. That the subsidence was of a gradual and tranquil nature is shown by the very existence of such remains. The features of a land surface are apt to become effaced immediately the play of the waves commences to be felt upon it, and even under the most favourable conditions many of the trees would become washed out of the soil, whilst others would be broken off short, so that their stumps alone remained. But loss of land through subsidence of the crust is a thing against which seaside authorities and Government departments might rage in vain. On the other hand, similar loss by erosion or denudation can be guarded against, and this is what is now so eminently desirable.

The Isle of Sheppey has been from time immemorial gradually slipping away into the sea, and the rich harvest of semi-tropical fossil fruits, turtles, &c., from its London Clay cliffs have enriched many a museum. A few miles farther east, on the North Kent coast, we see the wide stretch of flat meadow-land which extends in a south-easterly direction towards Richborough, marking the silted-up bed of the water-way which formerly divided the Isle of Thanet from the mainland. But with the destruction of the tertiary cliffs at Reculver it is probable that the sea would already have commenced to reassert its right to the old channel were it not kept back by artificial embankments. The Sister Towers, which were, two centuries ago, at least a quarter of a mile inland, now stand at the edge of a sea wall, reared by the Brethren of Trinity House.

The Isle of Wight is, geologically considered, but an outlier of the mainland, but the only historical reference to its former connection with England is contained in that much-quoted passage in Strabo, alleging that carts laden with tin used to pass to the island at low tide, in order to ship that much-prized commodity off to Phœnician markets. If one takes one's stand upon the Downs near to Tennyson's monument, and looks northward at low tide, one can easily conceive this to have been the case, seeing that in addition to the spit of land on which Hurst Castle is situated, numerous banks show themselves above low-water mark, and these are undoubtedly the remains of a connecting link, which must have been apparent not many centuries ago.

The broken condition of the coast between Alum Bay and Colwell Bay give evidence of great falls of cliff within modern times, and, indeed, geologically considered, there is no doubt that only a short time ago the Solent was but a river which emptied itself into the English Channel some distance beyond the Needles. At this time the gradual erosion of Spithead, which was going on, had not accomplished its work, and a bay stretched out between Selsea Bill and Culver Cliff. It is not a little remarkable in this connection that off Selsea there is an anchorage which is even now known as the Park. Probably the scour of the up-Channel tides had a good deal to do with the erosion of the bay, and even now the same action is responsible for a phenomenon here, which is found only at one other place on the south coast, namely, the movement of the shingle from east to west instead of from west to east. To the same cause may probably be attributed the arrival in glacial times of the numerous boulders of granite and other rocks foreign to the neighbourhood, which have been seen at low water on the Selsea coast. That erosion of the opposite coast on the island is still in progress is shown by the fall of tertiary cliffs which are frequently reported from Brading and the neighbouring east end of the island.

Wherever the coast-line is made up of soft or incoherent materials, from those parts comes the strongest call for protection against the inroads of the sea. On the iron-bound coasts of the west the battering-ram action of the sea has comparatively little effect. The submergence of Lyonesse, and the development of the hundred and fifty islands of which the Scillies consist, cannot positively be attributed to erosion any more than can the severing of St. Michael's Mount from the mainland. Possibly in both of these cases, as also in that of the development of the Bristol Channel, the present contour has been brought about by actual subsidence.

But it is on the south and east coasts where land is lost. The Oligocene and Eocene of the Isle of Wight; the Thanet Sands of Pegwell Bay; the Oldhaven Beds and Woolwich Beds of the Herne Bay coast; the London clay of Sheppey; the Red Crag (Pliocene) of Suffolk; the boulder-clay of East Anglia and of the Holderness district of Yorkshire; from all of these there comes the news of constant denudation, and it is in respect to some of these that Government action will have first to be taken, if the matter ever comes to be regarded as one in which the State should interfere.

New Radioactive Element.

MR. OSKAR KAHN, in fractionating a mixture of bromides obtained from thorianite, found that whilst the radium accumulated in the least soluble fractions, the radioactivity of the most soluble portions also increased. A strongly active oxalate precipitate of about 10 mg. was finally obtained, which glowed faintly in the dark and excited the platinocyanide and zinc sulphide screens in a marked fashion. If a current of air is blown through a solution of the substance and directed against a zinc sulphide screen, the illumination of the latter is somewhat similar to that observed in a parallel experiment with emanium. It is shown, however, that the substance cannot be actinium or emanium. The emanation from the substance is almost identical with that of thorium, but the substance itself is from 100,000 to 200,000 times as active as thorium, and is supposed to contain a new radioactive element.

XUM

The Coloration of Mammals and Birds.

By J. LEWIS BONHOTE, M.A., F.L.S., F.Z.S., M.B.O.U., &c.

(*Continued from page* 343.)

We will now turn to the second part of this paper, which deals with the markings on mammals and birds, our object being to show that throughout these groups certain SPOTS on the body will be found to differ in colour from the neighbouring parts, although in many cases the differences will be either so slight or so transitory in their nature that they cannot be said to serve any of the purposes usually ascribed to the agency of natural selection.

The conditions instrumental in bringing on a moult in mammals and birds are to my mind very obscure. A high temperature is undoubtedly a stimulating cause, as birds can be made to undergo a moult by merely keeping them in a warm atmosphere, but it is also necessary for a *successful* moult that the vigour of the animal should not be at too low an ebb, though, on the other hand, it need not necessarily be very high. The state of its "vigour" at the time of moult is visible in the *colour* of the new coat, rather than in a suppression or suspension of the moult. And birds in captivity in bad health will often show a tendency to become white. Nevertheless, it cannot be denied that moult is closely dependent on "vigour"; for although the moult will not be omitted if an animal's vigour be very low, yet the attempt will prove abortive and the animal will die. So that an animal cannot successfully moult without a certain amount of "vigour," but a moult will be attempted at certain fixed seasons, irrespective of that "vigour."

Shortly before a moult takes place an alteration will be visible in the colour of many mammals and birds; this alteration is always in the same direction, namely, a lightening or, as it has been termed "bleaching" of the hairs or feathers, followed (and this is especially noticeable in the latter) by a breaking up and complete disintegration of structure.

I have referred to this matter in two previous papers,* but it may well be dealt with more fully. It has been generally assumed that this "bleaching" process is gradual, and due to the action of weather and light alone. This, as I hope to show below, is not so; the actual disintegration may be brought about by the action of weather and light alone, but, if so, only after the hair or feather has been physiologically disconnected from the living tissues of the body. This latter process generally, but not always, takes place when a new hair or feather is beginning to be formed.†

One example of this is to be found in the so-called "white tail" assumed in summer by our English squirrel. Unlike the rest of its body, the tail is not moulted in spring, but shortly after the spring moult the tail begins to turn to creamy white, beginning at the tip and gradually spreading towards the base. Now, if this were merely due to the action of light, the "bleaching" would go on equally all over the tail, but this is not the case.

Of this form of "bleaching," which usually precedes a moult, I could instance numerous examples. In the case of the *Anatidæ*, or ducks, in which group all the primaries are moulted at the same time, the bleaching of these takes place about a fortnight before they are cast, the whole process taking ten days, or at the most, a fortnight, and yet during the first eleven months of their existence the change in colour was hardly noticeable.

This process of bleaching, however, need not always be caused by an approaching moult. I had a striking case some eighteen months ago exemplified by a *Gadwall*, which began to bleach about a month after he had moulted. In the course of a fortnight his wings and most of his body feathers were of a light dirty brown, and at the end of a month most of his feathers were entirely disintegrated and in shreds. I need hardly say that he was in very bad health. In the ordinary course of events these feathers would have lasted ten months practically unaltered, so that this disintegration cannot be put down solely to external causes. At the following moult the feathers were perfectly renewed.

The so-called abrasion of the tips of hairs and feathers is another cognate case, for, although it is generally assumed that the tips *gradually* wear off during the winter, I can, as regards birds, positively state that this is not so. To take a single instance out of many that suggest themselves. In the reed bunting (*E. schoeniclus*) the black bases to the feathers of the head will be obscured by the brown tips throughout the whole winter down to the middle of March, and yet, during the three weeks from the middle of March to the end of the first week in April, those tips will suddenly be lost and the whole bird will become brighter, this change taking place without the presence of a moult.

Is it probable that these tips, which have withstood the winter storms, should be washed away by April showers, unless there was some active physiological process behind it?

Many more instances could be quoted, but enough has been said to make it clear that "bleaching" only takes place when permitted to do so by physiological agency.

In my former papers, quoted above, several groups of squirrels in which the "bleaching" is marked were referred to, and it was pointed out that it was quite absent in some species and present in varying degrees in others very closely allied and inhabiting practically the same country.

Let us now carry the matter a step further and we will endeavour to show that *bleaching* is the *origin* of many of the markings and longitudinal stripes among mammals and birds.

The oriental genus of squirrels, known as *Ratufa*, offers the best examples for a study of this question.

The typical *Ratufa bicolor* of the Malay Peninsula is a large squirrel, deep glossy black above and light yellowish below. The new coat when first assumed is always black, but "bleaching" soon sets in, although the extent to which it is carried varies greatly among different individuals. In some cases the whole body becomes deep rufous brown, the legs and feet remaining black, while the hairs of the tail show a few red

* *Ann. and Mag. Nat. Hist.*, 1900, Ser. 7, Vol. 15, p. 492; *Zoologist*, 1901, p. 243.

† The leaves of deciduous trees offer a similar, though not precisely analogous case. They turn yellow in Autumn as soon as the sap ceases to reach them and the coating of bark tends to disconnect them from the trees. No one supposes the yellow and brown tints of Autumn to have been a gradual process going on throughout the summer, it does not commence until the leaf is physiologically disconnected from the tree. Leaves on a broken bough undergo a totally different change.

tips.* Should it get still lighter, the hairs will be found to be annulated with pale red until finally one may get the hair of a dirty creamy white, showing no trace of colour whatever. This is pure "bleaching," possibly a thinning of the pigment, which may be withdrawn for the use of the body as has been stated to take place in the whitening of the Arctic hare†.

Let us now take a nearly allied species from the Natuna Islands off Borneo, *R. bunguranensis*, and here we find the whole of the body of a brownish colour with rufous annulations, while the under parts are uniformly dark ferruginous, but almost immediately a new coat is assumed we find a *patch on either thigh bleaching*, which process rapidly spreads until the whole body is light buff; the under parts, however, not being affected to the same extent.

On the mainland of Borneo we have another species, *R. ephippium*, noticeable for its purity of coloration, very few of the hairs having subterminal annulations. From the top of the head to the root of the tail runs a broad and very dark brown stripe, slightly lighter on the shoulders and spreading out over the posterior part of the body; the rest of the flanks, sides of the neck, face and ears, ferruginous, fading into pale orange on the limbs, feet, and throat, the colour being palest on the forehead.

In *R. baramensis*, a local form of the above, we find the colour practically the same but lighter. Thus, along the back, we find the majority of the hairs with light annulations, instead of being self-coloured, though self-coloured hairs are still to be found along the back and across the rump. The rufous colour has disappeared from the sides of the body except on the cheeks, and the limbs and feet are yellow.

In *R. affinis*, a species from the south of the Malay Peninsula, the new coat is very light brown all over with still paler annulations, which almost immediately bleach to pale yellow.‡

We find, therefore, that we have in *R. bicolor* a species which in a new coat is pure black, but a species which, owing to bleaching, becomes very variable with light patches on various parts of its body, and, further, that other nearly allied species will have their colour permanently differentiated in lines and patches situated in places similar to those in which *R. bicolor* "bleaches."

Now, although in *R. bicolor* the amount of "bleaching" among various individuals may vary, yet the light-coloured patches will all start from certain definite "centres of bleaching," where "bleaching" will always first show itself, though it need not necessarily take place in all of them at the same time.

These parts of the body, which are "centres of bleaching," I propose to call "**poecilomeres.**"

The "poecilomeres," so far as *R. bicolor* is concerned, are situated as follows:—

The shoulders and thighs.
The crown of the head.
The tip of the nose and lips.
The tip of the tail.

In true *R. bicolor* one may find all variations. Sometimes the lightening process will start at the crown of the head and spread gradually over the back, becoming quite light across the shoulders and darker on the after part of the back, leaving the feet and legs black. At other times, starting from the shoulders and thighs, the bleaching will spread down the legs, leaving the body black and the legs light, the reverse of the previous case, or, sometimes, owing to the *thigh poecilomere* spreading forwards, a narrow light line will be formed between the colour of the back and the under parts.

In *Sciurus rufoniger*, a Sumatran squirrel of the *S. erythræus* group, we find this thigh bleaching rather more restricted and leaving a dark line of the colour of the upper parts between the "bleached" portion and the under parts. In this case we see, therefore, the beginnings of a dark as well as a light lateral line.

Now suppose, instead of these changes taking place during the life of the animal, that they should have become fixed and that the animal is, in consequence, born with a so-to-speak "bleached" pelage. The hair will not, strictly speaking, be "bleached," but it will differ in colour from the remainder of the body in the places where the poecilomeres should be. *Sciurus prevostii* and *Sciurus caroli* form very good examples among the squirrels, but the matter may be carried further than that; the white and black lateral stripes of the antelopes, the white lips of the same group, the white "blaze" of domestic horses and cattle, the white lips and feet of many ungulates, the starting point of the white back of skunks and ratels, the reddish thighs of some African jackals, white legs of the fox and polecat, light muzzles of many bears, light frontal patch of Bos frontalis; and among birds, to note but a few, the light patch above the beak of the white-fronted goose and the scaup duck, yellow on the crown of the goldcrest and many tyrants, light wings of pheasants, &c. Examples might be multiplied for ever, but enough has, I think, been said to show that these "poecilomeres" are of sufficiently wide occurrence to render it practically certain that they are due to something more than mere coincidence, and I suggest that we see their earliest beginnings in the "bleaching" of *Ratufa*.

As we examine more specimens it will be found that although some of these "poecilomeres" may be traced in almost all species that are not self-coloured, they will not always be *lighter* in colour than the rest of the body, but often, on the contrary, spots of more intense coloration, *e.g.*, buttocks of many monkeys, shoulders of the panda, forehead of okapi, red "blaze" of the goldfinch, red on occiput of many woodpeckers, &c.

We cannot give a thoroughly satisfactory explanation of this at present, but if it be once thoroughly established that (as Prof. Metchinikoff and Mr. Barcroft have proved for man, the dog, and the hare) colour may be, and is, extracted from the hair for the use of the body, it is only natural to suppose that any superfluous colour (supposing the pigment to be of nutritive value to the body) would be stored up where it might most easily be got at, should the body require it. Much more information is, however, required before this can be positively stated.

(To be continued.)

* Although rather beside the point it may make the matter clearer if I explain that in most animals the colours belong to one of two series, the actual shade of colour depending on the amount and concentration of the pigment. The series are:—(*a*) White, clay, light brown, dark brown, black (zoomelaiun). (*b*) White, yellow, orange, red (zooerythrin), and in a very concentrated form, black. It will thus be noticed that black may be apparent from either of these series. This will, I think, tend to explain "erythrism," a common variation among squirrels where they tend to become red, and will account in this species for red tips appearing on the black hairs when they begin to lighten. It also affords an explanation as to why the allied species tend to be red and white in their general coloration, e.g. *S. caroli* rather than black and yellow as in *R. bicolor*.

† *Barrett-Hamilton, Loc. cit.*—p. 307.

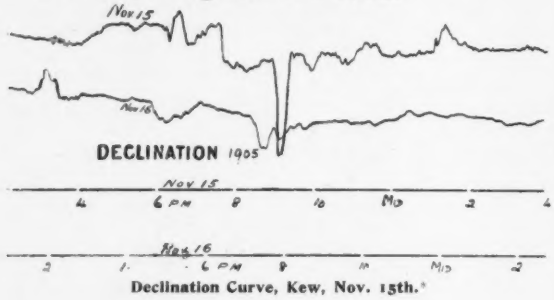
‡ For full descriptions of these species as well as of some to be mentioned hereafter see my papers in *Ann. and Mag. Nat. Hist.*, Ser. 7, Vol. 5—p. 490 (1900), and Ser. 7, Vol. 7, pp. 167, 160 (1901).

XUM

The Aurora of November 15th.

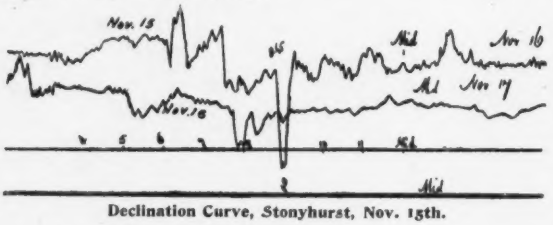
By W. SHACKLETON, F.R.A.S.

IN view of the wide-spread area over which the aurora of November 15 was observed, together with the simultaneous disturbance of the magnetic needle, it seems desirable to add to the few particulars given on page 293 in the issue of December last. Observations of the aurora are recorded from Värdo, Christiania, Szczawnica in Galicia (Karpathian Mts.), Wilhelmshaven (Germany), many places in France, England, and Ireland, and also from Nova Scotia; thus practically the whole of the northern parts of this hemisphere that were in darkness at the time of the occurrence have recorded the phenomenon. Most observers agree that the aurora was at its maximum about 9 p.m. (Greenwich time), but Mr. Roberts, writing from Welshpool, states that he observed a fine display, with a maximum brilliancy about 6.10 p.m.; others also record this. In Nova Scotia displays are recorded as taking place about 6 p.m. and also about 9 p.m.(Halifax time). From these observations it would appear that several displays occurred on the same date. The earlier display is probably coincident with an easterly movement of the declination needle, but the one coinciding with the greatest disturbance is the display observed about 9 p.m., and curves from the magnetic observatories of Wilhelmshaven, Kew, and Stonyhurst, all exhibit precisely similar deflections. Through the kind permission of the Director of the National Physical Laboratory, Dr. Chree has supplied us with copies of the Declination and Horizontal Force curves taken at the Kew Observatory, and a similar declination curve is exhibited from Stonyhurst College through the kindness of Fathers Sidgreaves and Cortie.



Declination Curve, Kew, Nov. 15th.*

It will be seen that about 9 p.m. a rapid easterly movement of the needle began, reducing the declination some 32′ in about 15 minutes, followed by an equally rapid return to the normal.

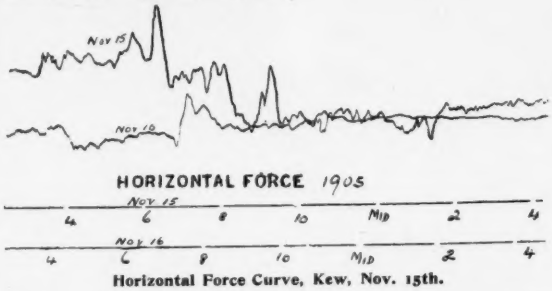


Declination Curve, Stonyhurst, Nov. 15th.

* Two days' records are taken on each photographic sheet; the upper is the earlier. The base line is the time scale.

The similarity of the curves is obvious, and Dr. Börgen, Director of the Magnetic Observatory, Wilhelmshaven, states that the large disturbance showed itself, in the same way, on the magnetic curves taken there.

The disturbances of the declination needle were accompanied by a sympathetic movement of the horizontal force magnet; the most prominent displacement, however, coincides with the aurora observed in the early evening, when the horizontal force increased by 105γ in about 10 minutes, and then fell 150γ in the next 20 minutes ($1\gamma = 10^{-5}$ C.G.S. unit).



Horizontal Force Curve, Kew, Nov. 15th.

After the disappearance of the aurora the needles continued to be disturbed, but not so violently, for about 30 hours.

Of the many theories put forward in explanation of the origin of magnetic disturbances, one naturally associates these particular ones with the co-existing auroræ.

The aurora of November 15 was particularly interesting on account of its vivid crimson tint, a type of aurora which is not common, the whitish yellow auroræ being more frequent. Observations from favourable localities like Värdo, state that the aurora was by far the most splendid seen for many years. Strong auroræ of this kind are rare in England, and it is a matter of regret that so few spectroscopic observations are forthcoming, especially as the origin of the auroral lines is not definitely known, in spite of the researches of Capron, Vogel, Huggins, Paulsen, and others. Usually, however, it is inconvenient to put aside a spectroscope suitable for this kind of work in the hope of an aurora coming along, and this may account for the scarcity of observations; yet every observer who looks for auroræ should be provided with a spectroscope, for it is well known that the aurora line is visible spectroscopically when the naked eye fails to detect any display, and, again, many reputed auroræ would be shown to be mere sky reflections if spectroscopic observations had been made.

Both Professor Fowler and myself made independent spectroscopic observations, but neither of us were able to bring a spectroscope to bear upon the display whilst the crimson rays lasted, and no trace of a red line was seen, though special search was made.

The common aurora line at λ 5,572 was very strong, and remained visible till midnight (as long as observations were continued), whilst, in addition, three other faint and more refrangible lines were seen.

The spectrum of the aurora is most probably a variable one, although the green line is persistent, but the phenomenon of gases exhibiting different spectra according to the nature of the electric discharge is common, and it seems probable that the various tints of auroræ may be accounted for by the varying electric discharges through some gas in the upper reaches of our atmosphere. The nature of this gas has not been

definitely origined, though Krypton seems to hold out the most promise.

Another theory advanced to explain the cause of auroræ is the pressure of light repelling some of the corpuscular matter surrounding the sun until it reaches the earth's atmosphere, the electrons being directed into the magnetic Meridian by the influence of the earth's magnetic field.

Whatever be the cause and nature of the aurora, there appears little doubt that auroral displays are very frequently accompanied by magnetic disturbances, though the converse does not hold.

CORRESPONDENCE.

The Evolution of the Flower.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—There are a few rather important oversights in Mr. S. L. Bastin's paper on the above very interesting subject, which I venture to suggest might be mentioned, as well as a few additions made; for since the paper is evidently intended for beginners in Botany, a few extra remarks might supply an additional interest to the subject.

Comparing the use of flowers with vegetative methods of propagation, the latter is often much more important than the reader might, perhaps, suppose. Of course, annuals depend entirely upon seed; but perennials often multiply for far longer periods than might be inferred from the expression, "for a time at any rate." This may be enlarged to upwards of a century—*e.g.*, with *Oxalis cernua*, introduced into Malta from the Cape before 1804; for it has spread, and is still doing so, by means of bulbs, along both north and south shores of the Mediterranean Sea, but never sets seed at all throughout that region. Our pilewort, too, rarely seeds.

The object of Mr. Bastin's paper is to show that the four organs of a flower—the sepals, petals, stamens, and carpels—are fundamentally "homologous" with leaves; *i.e.*, they might have grown out into true leaves had they not appeared as these organs. A little modification is here required; for it is rare to find the sepals, for instance, as representing a *whole leaf* or stalk and blade together. It usually corresponds with the stalk or "petiole" only, as may be readily seen in a rose. Very occasionally is a sepal the same thing as the blade, as in the corn-cockle.

Similarly, petals usually correspond only to the "filament" of the stamens, so well described by Mr. Bastin in the Water-lily or in Canna; but in the Ranunculus family it is the "anther" of the stamen which is converted into the petal. The student should compare the "nectaries" of *R. auricomus*, *R. Ficaria*, and other species, and he will soon discover *transitional forms*, showing that while one half, the outer, of the anther grows into the broad yellow petal, the other, or inner half, remains arrested, like a tiny flap; in the spot between the two, corresponding to the bottom of the anther-cells, honey is secreted.

The little honey-pots of Hellebores and Winter Aconite are similarly constructed out of anthers.

The "spurred" petals of the Columbine afford another good illustration; while in "double" Columbines the numerous "spurs" of the converted anthers fit into one another in radial rows.

In the "green rose" and Alpine Strawberry every part of the flower is represented by a small green leaf; some of them may still carry an anther-cell showing, as Mr. Bastin explains, their true homology.

The first stage, therefore, was the conversion of leaves or "leaf-scales" into carpels and stamens. This stage is seen in the *male* flowers of Juniper and Cypress, though, unfortunately, we have no good case of a "Gymnosperm" passing into an Angiosperm, the former having no indisputable representation of a "carpellary leaf" at all.

The second stage was to construct petals out of stamens, as stated.

In all the above plants mentioned the organs are "free," but "cohesion" often stepped in and united the parts of the "whorls" together. Mr. Bastin alludes to Campanulas in illustration, but here the five united petals make the bell, while the five sepals are external to it, and more or less joined together, but not to the petals to form the bell (which has only five free tips) as suggested by Mr. Bastin. Indeed, in a garden variety called the "Cup and Saucer," it is the broad, flattened out blue calyx which makes the saucer, while the corolla is the cup within it.

It sometimes happens that the sepals of flowers are white or coloured, as Mr. Bastin observes. Then they *look like petals*, and are called "petaloid." Such is the case with several members of the Ranunculus family, as *Clematis*, *Anemone*, *Calha*, *Aconitum*, and *Delphinium*, but *they must not be confounded with petals.*

When such flowers become "double," it is not the sepals which multiply, but the petals, together with the stamens and carpels, which latter are now represented by petals, of which the whole number may be upwards of fifty, as in a stock, and many more in a garden Ranunculus.

In Monocotyledons, such as tulips and hyacinths, the sepals and petals had better not be described as "identical," except as to colour and form.

Botanists regard them as being *two* distinct whorls, the outer and the inner, at least when the parts are not united as in a tulip, but they may be united as in the garden hyacinth. Nevertheless they should be regarded really as 3 + 3 rather than 6 in one whorl.

Bracts, too, are rudimentary forms of leaves, being either homologous with petioles only, as in Hellebores (*H. fætidus* is an excellent illustration of a perfect transition in the reduction and loss of blade, with a diminution of the petiole into a bract) or of the blade only, as in Buttercups.

Sometimes the bracts are brightly coloured and may puzzle beginners. But they are always *outside* the flowers, often including *several flowers*, as in Euphorbias and three in Bougainvillea, a proof that they are not really parts of a flower.

They not infrequently mimic a flower. Thus species of *Cornus* has four large white bracts, numerous minute flowers being within them. It thus looks like the flower of a Clematis, which may have four white sepals. A species of Euphorbia has five rounded scarlet "glands," exactly imitating a five-petalled flower!

It is only by a careful examination, which the beginner should always make, before the imitation is detected.

All these coloured organs, as Mr. Bastin rightly observes, are to attract insects for pollenation. Nature sometimes goes so far as to put all her energy, so to say, into the corolla, as to even sacrifice the stamens and pistils. Such is the case with the outermost flowers of a truss of *Hydrangea*, which has only a coloured calyx, and the Guelder-rose, which has only a corolla. Such, too, is the case with the large trumpet-shaped "ray" florets on the head of a *Centaurea*. The outermost flowers of these plants have sacrificed their power of setting seed for the benefit of the community, consisting of inconspicuous but fertile flowers in their midst.

As sepals, petals, stamens and carpels will sometimes "revert" to be represented by true leaves, so may bracts. It is not uncommonly so with plantains. Each of the numerous, minute flowers which form the dense spike, stand in the "axil" of an extremely minute bract. Sometimes, however, these bracts become "foliaceous" and grow out into small leaves.

In the "Green Dahlia," the usually colourless bracts or scales, hidden among the flowers, become large, thick and green, all the florets being totally arrested. This change is expressed as the result of the "law of compensation," when one organ is enlarged at the expense of another; but why these changes take place is a problem which cannot always be solved; but the lesson we learn from all this is, the wonderful power Nature possesses of constructing any organ she pleases out of any other. It is not only in flowers, but a general capability, and is most admirably seen in such curious adaptations as the means of climbing and of catching and devouring animal prey, &c.

GEORGE HENSLOW.

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To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—After reading Professor George Henslow's letter, in which he takes me to task for certain omissions in my paper, "The Evolution of the Flower," I am led to think that he can scarcely realise the vastness of this subject. Why, the additional examples which he thinks should have been included might be multiplied by one hundred fold! Moreover, several of the points to which he alludes were hinted at in my article, but space would not permit of their enlargement.

If Professor Henslow will refer to my text he will notice that after remarking that the sepals and petals of the Tulip flower are identical, I have placed the saving clause "as far as the ordinary observer can say." I am glad that

Sutton & Sons. *Reading.*

Gloxinia. "Cup and Saucer" Variety.

attention has been called to the error which has crept in by an oversight regarding the sepals and petals of Campanulate flowers; of course, the "bell" is only formed of the petals, the calyx being quite distinct. The same point is illustrated in the tube-shaped flowers of the Gloxinia, an interesting "cup and saucer" variety of which has been recently introduced. By the courtesy of Messrs. Sutton and Sons I am able to send you a photograph of this remarkable form.

I should like to thank Professor Henslow for his elaborations of many points concerning which I had to deal all too briefly.

Yours etc.,

S. LEONARD BASTIN.

February 13, 1906.

The Green Flash at Sunset.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

DEAR SIRS,—Having seen a letter in your last issue (February, 1906) concerning the so-called green flash at sunset, I think it may be of interest to the writer of the letter and some other readers to hear of some of my observations on the phenomenon. Therefore, I am sending some extracts from my notebooks. The last one is especially interesting, as the position of observation and weather were very favourable, and also as I was expecting the occurrence. From the descriptions in my notes, I feel quite sure that the phenomenon is not an optical illusion, but an objective reality caused by the refraction of the air which acts like a prism upon the last rays of the setting sun, giving rise to a series of colours as observed ranging from the red to the extreme violet end of the spectrum.

I have noticed the same red flashes in Venus, and also Jupiter and several other stars when I have seen them setting behind the mountains in Egypt, near Assouan.

I have seen the green, or rather many-coloured, flash also behind the mountains at sunset in Egypt; but it is neither so clear nor of such long duration when seen over land as over sea.

Here are the extracts:—

1902, March 29.—Sunset well seen, vivid blue line (at sea, near Alexandria).

1901, Nov. 17.—Sunset, last arc disappeared 5 hrs. 2·2 min. ship's time off Corfu or Ionian Islands (not in sight). (At sea.)

1902, Feb. 2.—Venus set over mountains about 6.40 p.m. (Cairo time) at Assouan. The red colouring on the crescent in flashes was conspicuous.

1903, Aug. 31.—At Scourie, Sutherland, N.B., and Lat. 58° 21′ N. Long. 5° 9′ W.

7.25·5 p.m.—At the last contact of the sun's upper limb, the "blue line" appeared. When the sun's *lower* limb was about 15′ above horizon, it appeared intense red.

The blue line began to show evidence of its coming about 30 seconds before the sun disappeared. At first the whole of the visible portion of the disc of the sun turned intense fiery red. Then when a little more than half the disc had disappeared it changed to yellow. Then when only about 1-6th was left, there were green flashes round the edge of the disc lasting perhaps a second each, and passing round a short arc beginning always at the horizon. Then similar blue flashes appeared. Then when the sun is almost down the whole visible part became greenish with violet flashes. Then the part of the disc visible becomes a line with deep violet at each end, blue next to the violet, and green in the middle parts of the line. Then the violet takes the place of the blue, and blue is in the middle, while deeper, almost ultra violet, colours the ends of the line. Then there is a lingering, rippling flash of deep violet, and the sun is gone.

The flash (as a whole) was much clearer and lasted longer than I have ever seen it before. The telescope used was about 1¾ in aperture, with magnifying power 45.

The sea horizon was perfect, and the altitude above sea-level about 55 feet; weather calm, light S.W. wind; filmy clouds in part of the sky, part clear with cloud wisps like nebulæ. Temp. about 52° F.

This description I copy from my notes written on the spot the same evening.

I used no dark glass on the telescope.

I am, Sir,

Yours very truly,

JAMES H. WORTHINGTON.

25, Museum Road, Oxford.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—Rèferring to Admiral Maclear's letter on this very interesting and beautiful phenomenon, I have been much at sea, and have always taken great interest in, and watched at every opportunity for a sight of it. I have heard all sorts of

causes assigned, some rather ludicrous—*e.g.*, that it resulted from the light passing through a film of water as the sun dipped below the horizon. On the whole, I think Admiral Maclear's quotation from Professor Davis' work appears the most probable solution. I have noticed, in a favourable display, that the "flash" changes rapidly from green to blue and violet, which bears out Professor Davis' theory—the red and yellow parts of the spectrum being lost in the general brightness of the sky.

With respect to your editorial note, I would mention that far the finest view of the "green flash" is to be obtained, according to my experience, oft repeated, at sunrise, when there has been no previous "glaring" of the eye to cause the complementary colour-effect. The observation is more uncertain owing to the difficulty of knowing *exactly where* the sun will appear. But a look at the azimuth and amplitude tables enables one to set the sight of the standard compass exactly on the point, as a guide to the eye. And the horizon is more apt to be clear and sharp at sunrise than at sunset, while the brilliance of the flash to the un-tired eye is magnificent. I remember once in the South Atlantic lying in my bunk watching a barque on the horizon, silhouetted black against the eastern sky, and framed in the port-hole, when the sun rose exactly behind it, and the sight was simply too beautiful for words, from the play of bright blue and green light among the tracery of masts and rigging. I have seen the flash *twice* at the same sunset, as we rose and fell on mighty rollers in the Southern Ocean off Cape Leeuwin, of which I sent an account to *Nature*. Some time in the late summer of 1891 I was always careful in watching a likely sunset never to look *directly* at the sun till the last moment, to avoid fatiguing the eye with glare. Also, the best shows were when the sun, on the horizon, was much distorted by refraction.

C. MOSTYN.

Tunbridge Wells, February 17, 1906.

Mr. F. W. Levander, Editor of the Journal of the British Astronomical Association, informs us that several communications on the phenomena referred to above are to be found in vols. 7, 8, 10, 11, 12, and 15 of that Journal.

Electric Induction Experiments.

DEAR SIR,—My attention has been called to an article which appeared in your journal for August last, on "Some Electrical Influence Experiments," by Mr. Charles E. Benham. The conclusions arrived at in that paper seemed to be so extraordinary, and so opposed to scientific principles, that I have taken the trouble to repeat Mr. Benham's experiments. Preparing three sheets of glass similar to those shown by Mr. Benham in Figs. 1 and 2, page 196, I repeated the experiment as described in your journal, and got the same results as Mr. Benham. But if his interpretation be correct, namely, that the electrification is not due to friction, we would have all the conditions necessary for producing perpetual motion, as the energy necessary for making the successive contacts would be less than might be developed by the electricity. For this reason the presumption was there was an error somewhere.

To find out what was taking place, I connected by means of a fine wire the upper tinfoil F (see Benham's figures) with a gold leaf electroscope, the plates being in position. The strips of tinfoil on the lower plate were now successively earthed, then the upper one was earthed, the lower ones being again earthed in succession, then the top one, and so on a great number of times. The upper plate was now raised, but it showed no signs of electrification; a result one would naturally expect. Instead of now simply earthing the tinfoils on the lower plate by simple contact without friction, they were earthed as described by Mr. Benham, by drawing the finger over the lower surface of the plate so as to earth them in succession as before. When this was done the electroscope showed signs of divergence, which fell on the upper plate being touched, and again rose on stroking the under plate, showing that the earthing of the lower tinfoils by stroking gave rise to a disturbance of the electrification. When this process was repeated a number of times the plates acquired a considerable electric charge. If after the plates have become charged in this manner we simply touch the lower plates in succession, and then the upper one without friction, and do it a number of times, the plates gradually get discharged, as one would expect, the process being a step-down discharge.

With regard to Mr. Benham's statement that the electric charge cannot be due to friction, because after the manipulations described by him the plates are sometimes positive and sometimes negative. On putting this point to the test, I find that shellac varnish on glass when rubbed with the hand is sometimes electrified + and sometimes —, which explains the change of electrification in Mr. Benham's experiment. At first this change in the electrification seemed to be capricious, and it was hard to say what electrification it would take; but at last it came out that the sign of the electrification depended on a number of things. The varnish used in these experiments was the ordinary commercial spirit varnish. The plates were coated by pouring the varnish over them, draining the surplus off, and drying with heat. It was found that one piece of glass so treated became positively electrified when rubbed with the hand, while another piece became negatively electrified, but the electrification of neither of them was constant. In damp air what was previously + became —, whilst the one that was — remained so, but became + when the air was very dry. If the skin of the hand is dry it tends to give +, and if moist —. The tip of the fingers may give +, while the pad formed by closing the thumb on the first finger gives —. A moist, newly-washed skin gives —, and a dry one +. If the surface of the varnish be smooth it tends to give +, while if rough to give —. If in place of using the whole varnish, only the clear upper part that forms after the varnish has been standing some time be used, it gives a very fine, smooth surface, which seems to give + in most conditions of humidity of the air, but becomes — if a very little olive oil or other similar substance be on the fingers. From the above, as might be expected, it is no unusual thing for a piece of glass to give electricity of one sign on first rubbing, and of the opposite sign on the second rubbing, changing about in a seemingly capricious manner, but in reality in response to changes in the rubber or surrounding air. Spirit varnish generally contains two gums, and the different proportions of these on the plate seem to determine whether it will tend to give + or — electricity.

J. A.

The Electric Production of Nitrates from the Atmosphere.

Abstract of a Discourse delivered at the Royal Institution on Friday, February 2, 1906, by

PROFESSOR SILVANUS P. THOMPSON, D.Sc., F.R.S.

As the demand of the white races for wheat as a food-stuff increases, the acreage devoted to wheat-growing increases, but at a less rapid rate; and being limited by climatic conditions will in a few years, perhaps less than thirty, be entirely taken up. Then, as Sir Wm. Crookes pointed out in his Presidential Address in 1898, there will be a wheat famine, unless the world's yield per acre (at present about 12.7 bushels per acre on the average) can be raised by use of fertilisers. Of such fertilisers the chief is nitrate of soda, exported from the nitre beds in Chili. The demand for this has risen from 1,000,000 tons in 1892 to 1,543,120 tons in 1905; and the supply will at the present rate be exhausted in less than fifty years. Then the only chance of averting starvation lies, as Crookes pointed out, through the laboratory.

In 1781, Cavendish had observed that nitrogen, which exists in illimitable quantities in the air, can be caused to enter into combination with oxygen, and later he showed that nitrous fumes could be produced by passing electric sparks through air. Although this laboratory experiment had undoubtedly pointed the way, though the chemistry of the arc flame had been investigated in 1880 by Dewar, and though Crookes and Lord Rayleigh

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had both employed electric discharges to cause nitrogen and oxygen to enter into combination, no commercial process had been found practical for the synthesis of nitrates from the air, until recently.

After referring, in passing, to the tentative processes of Bradley and Lovejoy, of Kowalski, of Naville, and to the cyanamide and cyanide processes, attention was directed to the process of Birkeland and Eyde, of Christiania, for the fixation of atmospheric nitrogen, and their synthetic production of nitrates, by use of a special electric furnace. In this furnace an alternating electric arc was produced at between 3,000 and 4,000 volts, but under special conditions which resulted from the researches of Professor Birkeland; the arc being formed between the poles of a large electro-magnet, which forced it to take the form of a roaring disc of flame. Such a disc of flame was shown in the lecture theatre by a model apparatus sent from Christiania. In the furnaces, as used in Norway, the disc of flame was four or five feet in diameter, and was enclosed in a metal envelope lined with firebrick. Through this furnace air was blown, and emerged charged with nitric oxide fumes. These fumes were collected, allowed time further to oxidise, then absorbed in water-towers or in quicklime—nitric acid and nitrate of lime being the products. The research station near Arendal was described; also the factory at Notodden, in the Hitterdal, where electric power to the extent of 1,500 kilowatts was already taken from the Tinnfoss waterfall for the production of nitrate of lime. This product in several forms, including a basic nitrate, was known as Norwegian saltpetre. Experiment had shown that it was equally good as a fertiliser with Chili saltpetre; and the lime in it was of special advantage for certain soils. The yield of product in these furnaces was most satisfactory, and the factory at Notodden—which had been in commercial operation since the spring of 1905—was about to be enlarged; the neighbouring waterfall of Svaelgfos being now in course of utilisation would furnish 23,000 horse-power. The Norwegian company had further projects in hand for the utilisation of three other waterfalls, including the Rjukanfos, the most considerable fall in Telemarken, which would yield over 200,000 horse-power. According to the statement of Professor Otto Witt, the yield of the Birkeland-Eyde furnaces was over 500 kilogrammes of nitric acid per year for every kilowatt of power. The conditions in Norway were exceptionally good for the furnishing of power at exceedingly low rates. Hence the new product could compete with Chili saltpetre on the market, and would become every year more valuable as the demand for nitrates increased, and the natural supplies became exhausted.

What is at the Centre of the Earth?

By H. DE ST. DALMAS.

THE mystery of this question is assigned as one reason for its investigation. It is, indeed, remarkable that less should be known about the earth's composition, even at the depth of a few miles, than is known of the composition of stars millions of miles away.

In "KNOWLEDGE" for January doubt is cast on the generally accepted theory of a regular and sustained increase of heat as the earth's crust is penetrated. The data are not sufficient to establish this theory. The increase of heat in deep mines and borings has been attributed to the central heat of a gradually cooling planet. How can we know that this is the true cause of the heat at only a mile or two from the earth's surface, seeing there is no proof that the fiery heat extends to the earth's centre?

Reasoning on the effects of pressure at various depths, Mr. Beresford Ingram suggests that the earth may consist of "three concentric rings," having a solid nucleus from 3,000 to 7,000 miles in diameter, next a liquid substratum, and finally the earth's crust, variously estimated at from 70 miles to 2,000 miles in thickness.

Dr. Edmund Halley propounded a similar theory of the earth's composition before the Royal Society in 1694. The mysteries of terrestrial magnetism seemed to point to such an arrangement to account for the uniform slow revolution of the magnetic pole round the pole of the earth. The nucleus (or *Terrella*) imagined by Halley, though concentric with the main body of the earth, he maintained rotated on a different axis, the axis of the nucleus being indicated by the magnetic poles. Halley considered that the axis of the nucleus was originally that of the entire earth, and that a change of axis had taken place in relation to the outer globe, this being the physical cause of the deluge, as it would necessarily bring the ocean waters and Arctic ice over mountains and continents.

Halley maintained this belief more than thirty years till his death. The late Sir Edward Sabine, speaking from the Presidential chair of the Royal Society in 1864, said that "the objections that might have impeded the reception of such an hypothesis . . are no longer tenable."

The late astronomer royal, Sir George Airy, expressed the opinion "that the general cause of the earth's magnetism still remains one of the mysteries of cosmical physics." The distinguished Lord Kelvin has expressed himself similarly only a few years ago. So that we are now no further advanced in actual knowledge of the earth's interior and of terrestrial magnetism, than when Halley maintained more than 200 years ago that "thus and not otherwise" could the facts be explained.

Halley's theory of the earth has been popularised by the late Rev. W. B. Galloway, M.A., in "Science and Geology in Relation to the Universal Deluge" and "The Testimony of Science to the Deluge." Mr. Galloway shows that the specific gravity of the earth being about 5½ times that of water, whilst the rocks at the earth's surface do not average more than 2½, it follows that the heaviest substances, such as gold and platinum, should be at the centre, and that mercury or quicksilver, in harmony with its specific gravity, might form the liquid substratum between the two differently rotating globes. The arguments—astronomical, geological, climatic, and historic—in support of Halley's and Galloway's theory of the earth are well worthy of examination.

Whilst astronomers and geologists cannot tell if the earth has a rigid core or a molten interior, the hypothesis of "three concentric rings" should not be regarded as untenable, *i.e.*, an inner and an outer globe with a fluid substratum, such as mercury, petroleum, or molten lava (all of which have been suggested) interposed between the *Terrella* and the outer globe. In such case the heat, which is found to increase in descending below the earth's surface, might be caused by the friction of two differently rotating bodies, and not by imaginary fires at the centre of the earth.

Rare Living Animals in London.

By P. L. SCLATER, DR.SC., F.R.S.

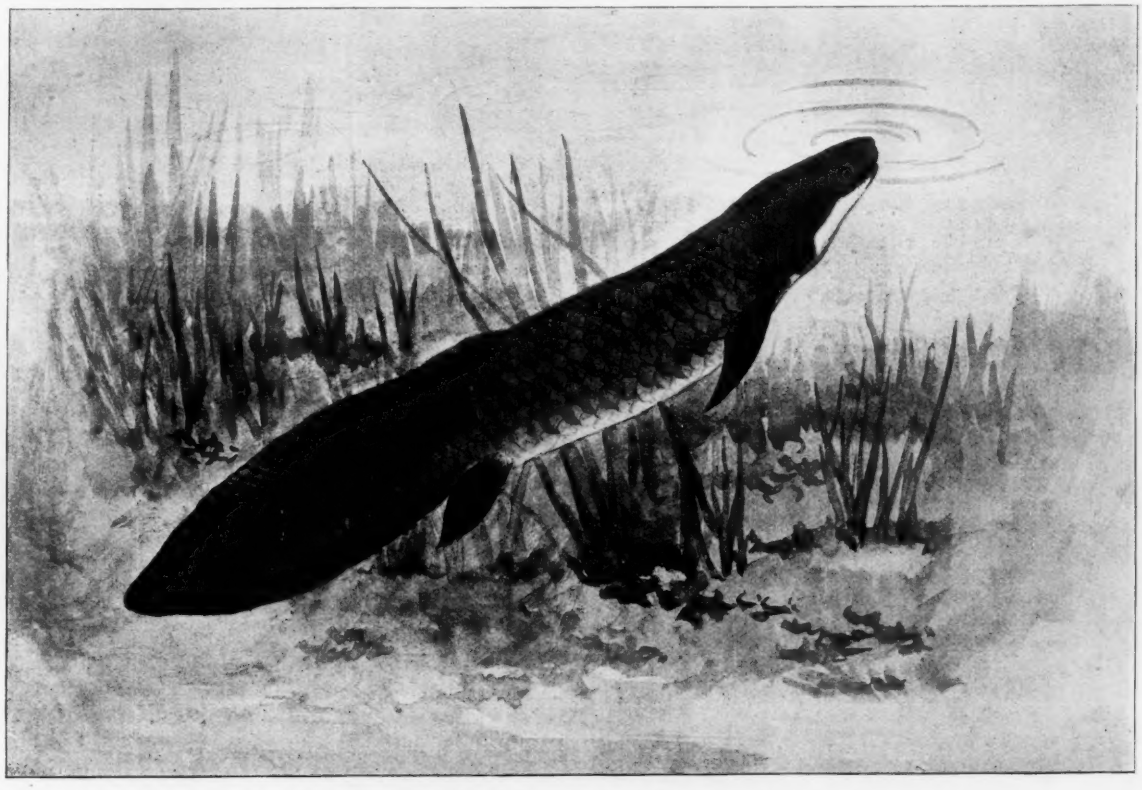
VI.—Forster's Lung-Fish (*Ceratodus forsteri*).

A "QUEER FISH" is a proverbial expression, and is certainly very applicable to the fish now figured from one of two specimens received by the Zoological Society in 1898, and still living in one of the large tanks in the reptile house.

For many years there had been known from the Triassic strata of various parts of Europe, certain fossil teeth of fishes of a remarkable character. From their fancied resemblance to deer-antlers these teeth, which were the only part of the fish known, were named *Ceratodus*, or "Horn-tooth." Similar teeth were subsequently obtained from the secondary strata of India, and from the Jurassic rocks of Colorado and Montana, in North America, but little, if any, additional information about them was procured. Suddenly, in 1870, the extraordinary discovery was made that this "queer fish," or, at any rate, one with similar teeth, was actually still existing in certain rivers of Queensland, where it is known to the natives as the "Barramondi."

The naturalist who first made known this remarkable fact, was the late Gerard Krefft, a corresponding member of the Zoological Society of London, and for many years curator and secretary of the Australian Museum, Sydney. Krefft had obtained his specimens from Mr. William Forster, M.C.A., and published a description of them in the "Proceedings" of the Zoological Society, under the name *Ceratodus forsteri* (see P. Z. S., 1870, p. 221). He referred them, no doubt correctly, to the genus *Ceratodus*, by which name Agassiz had designated similar teeth in his "Recherches sur les Poissons Fossiles."

The Barramondi is, in these days, found in a state of nature, only in two little rivers of Queensland, the "Burnett" and the "Mary," though its fossil remains prove that it formerly extended over a far larger portion of Australia. The best account of its life and habits will be found in Dr. Richard Semon's most interesting work "Im Australischen Busch," of which an English translation was published in London in 1899. The same author has likewise devoted a whole volume of his "Zoologische Forschungsreisen," to a monograph of this extraordinary fish.



Forster's Lung-Fish (*Ceratodus forsteri*).

The first, and, as I believe, the only specimens of the *Ceratodus* ever brought to Europe alive, were received at the Zoological Society's Gardens in June, 1898. Four of these fishes, captured in the River Mary, were safely conveyed to England by Mr. D. O'Connor. Two of them were purchased by the Zoological Society, for the sum of £45, and, as already stated, are still living in the Gardens—much increased in size and condition. The two others were taken by Mr. O'Connor to Paris and sold, I believe, to the Jardin des Plantes. I do not know whether they are still alive or not.

Mr. O'Connor gave the Zoological Society the following account of the capture of his specimens of the *Ceratodus*:—

"Some ten or twelve years ago, the late Sir Ferdinand von Mueller and other scientific men of

Australia, were apprehensive that *Ceratodus* was likely to become extinct, mainly owing to their being largely destroyed by settlers and miners, who highly esteemed them as an article of diet. They were mostly killed by dynamite, a very destructive agent. The curious fact was also noted that no small specimens of *Ceratodus* were ever seen; two of those brought to your Gardens are the smallest I ever met with, excepting a stuffed specimen, which measured 21 inches. The Royal Society of Queensland, with a view to the preservation of *Ceratodus*, resolved to remove specimens to new habitats, and I was asked to undertake the work. My first month's experience was very discouraging, resulting in only one live fish, but better success followed, and in less than six months, sixty-nine examples were transported to six new localities. This success encouraged me to try the experiment of taking a few to England. I had some caught and kept in captivity a few weeks, and fed mainly on prawns. They were shipped in the *Duke of Devonshire*, on the 15th of April, and arrived in London on the 12th of June, after a passage of eight weeks. My success was mainly owing to the exceptionally fine weather enjoyed throughout the voyage, there not being an hour rough between Brisbane and the Thames."

Ceratodus belongs to the "Dipnoan" (or double-breathing) Order of Fishes—so called because they breathe not only by their gills, as ordinary fishes, but also by their lungs, like the higher vertebrates.

Our picture (page 379), represents one of these fishes coming up to the surface of the water, as they frequently do, to imbibe a little more oxygen.

Besides *Ceratodus*, there are two other fishes belonging to the formerly widely-spread Order of Dipnoans, the *Lepidosvien* of South America, and the *Protopterus* of Africa. These three forms are the sole survivors of this great group, which in former ages was extensively distributed over the earth's surface.

Star Map No. 5.

THIS map shows Orion in the right hand top corner, Sirius towards the centre, and the "False Cross" at the bottom. Several fine stars are included in this region.

β *Orionis* (*Rigel*), magnitude 0·3.

Nebula Orion M 42 (V h. 30 m. 5° 30′ S.), the greatest nebula in the heavens. Although only the nucleus is readily visible, the nebula extends for vast distances all around. Its spectrum shows it to be gaseous.

θ *Orionis* (V h. 22 m. 50° 28′ S.). A multiple star in the brightest part of the above nebula. Four stars of 6, 7, 7½, and 8 magnitude form a trapezium.

σ *Orionis* (V h. 34 m. 2° 39′ S.) "the hilt of the sword," is a multiple star, consisting of 2 sets of treble stars, as well as others.

α *Argus* (*Canopus*) (VI h. 21 m. 52° 38′ S.). The second brightest star; magnitude – 1·0.

α *Canis Majoris* (*Sirius*) (VI h. 41 m. 16° 35′ S.), magnitude. – 1·4. The brightest star in the heavens. It has a small companion, magnitude ·9, at a distance of 6″·3. The light is calculated to be 30 times as bright as that of the Sun, while the mass of the star is only 2½ times as great. Sirius is one of the nearest of the stars, the distance being 8·6 light-years. Its parallax is ·38.

α *Canis Minoris* (*Procyon*) (VII h. 34 m. 5° 28′ N.) is another near and bright star. Its parallax is ·3; distance in light-years, 10·9. Magnitude, 0·5. It is accompanied by a large and feebly luminous companion, giving out only about one-thousandth the amount of the light of the Sun.

Qualitative Analysis Without the Use of Hydrogen Sulphide.

By H. J. H. FENTON.

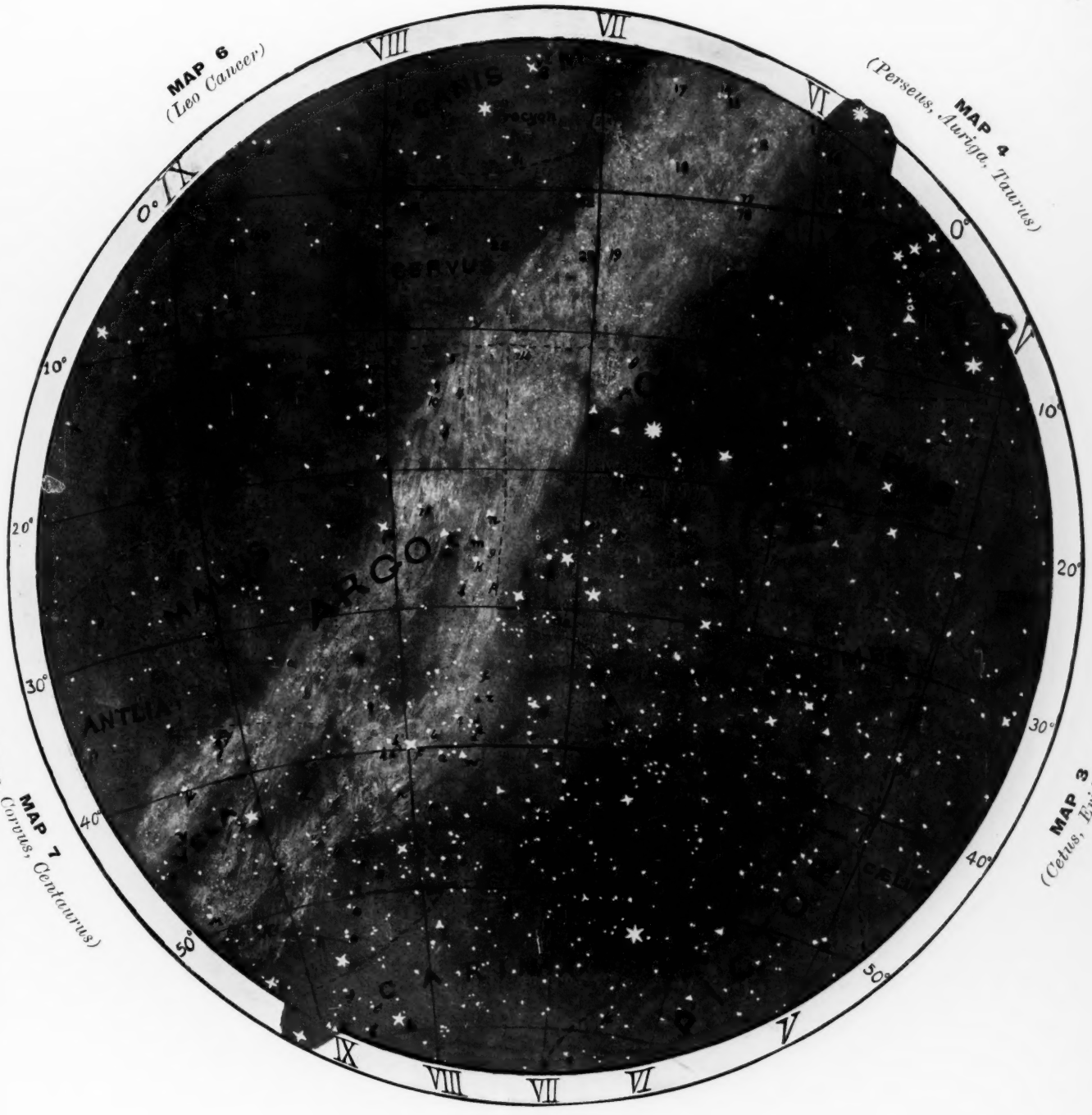
THE separation of metals belonging to the "second group" by means of hydrogen sulphide, in presence of dilute hydrochloric acid, has hitherto been universally regarded as one of the principal and essential stages in systematic qualitative analysis. This method—originally devised by Bergmann and improved later by Fresenius—may, of course, yield excellent results if due precautions are taken; yet from a theoretical standpoint it is anything but perfect, since the conditions (concentration, degree of "acidity," temperature, etc.), which are favourable to the most complete precipitation, vary considerably with the different sulphides.

On the practical side the objections are more serious, especially in view of the highly offensive and even poisonous nature of the gas; there are difficulties also, especially in small laboratories, in arranging for a constant and regular supply, and considerable waste invariably results owing to the excessive rate at which the gas is passed and the inveterate tendency of students to "leave the tap turned on."

In consequence of these objections many attempts have from time to time been made to devise methods of separation which are independent of the use of hydrogen sulphide. Klein, for example (1887), proposed the use of ammonium dithiocarbamate, Vogtherr (1898), of ammonium dithiocarbonate; and Schiff and Tarugi (1894), of thioacetic acid or its salts. Rawitsch (1899) avoided the use of hydrogen sulphide itself by digesting the mixture to be analysed with excess of yellow ammonium sulphide, and subsequently treating both residue and solution with dilute hydrochloric acid. None of these suggested modifications, all of which, it will be observed, make use of sulphur compounds, have received much support from chemists; either the preparation of the reagent in question presents difficulties or else the method of separating the resulting compounds is found to be imperfect.

A paper has recently been published by Ebler [Zeitschrift für Anorganische Chemie, 1905 (48) 61], in which he proposes to get over the above-mentioned difficulties by entirely different methods and by employment, in some cases, of reagents which, although comparatively new, can now be easily obtained as commercial articles. Possibly amongst our readers there may be some who are interested in analytical chemistry, but who have not the opportunity of studying the recent literature on the subject, and to these a brief sketch of the paper may be of advantage.

In constructing this new scheme of analysis the author takes advantage especially of the tendency which certain metals have to form complex cations, of various degrees of stability, with ammonia, and he employs as reagents, in addition to those in common use, such compounds as hydroxylamine, hydrazine, and potassium percarbonate.



BRIGHTNESS.

- 1st Mag.
- 2nd ,,
- 3rd ,,
- 4th ,,
- 5th ,,
- 6th ,,
- Variable
- Nebula.

MAP No. 5.

Argo, Canis Major.

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It is necessary in the first place to remove tin and antimony, since they are only partially precipitated by the ammoniacal reagents employed; arsenic and phosphoric acids have also to be got rid of, since they would cause complication in precipitating the heavy metals, magnesium, &c. The solution to be examined is, therefore, evaporated repeatedly with concentrated nitric acid; this converts tin and antimony into the insoluble metastannic and antimonic acids, in which form they are easily removed. Phosphoric acid is eliminated by the well-known tin method, and arsenic, if present, is either vaporised away as methyl arsenate (by distilling with methyl alcohol and hydrochloric acid), or is rendered "harmless" by reduction to the arsenious state. In order to bring about the latter change the author employs a mixture of fuming hydriodic acid and hydrazine chloride; the reduction by hydriodic acid alone is limited and reversible, but the hydrazine (by reconverting I into HI) renders it complete.

Silver is separated in the usual manner by hydrochloric acid and the solution (2), which may now contain the remaining (common) metals—Fe, Pb, Bi, Al, Cr, Hg, Cu, Mn, Zn, Cd, Ni, Co, (As^{III}), Mg, Ba, Sr, Ca, K and Na—is mixed with hydroxylamine hydrochloride and excess of ammonia; it is then heated in a water-bath until the odour of ammonia nearly disappears. In this way, aluminium, iron, chromium, bismuth, and lead are precipitated as hydroxides, and mercury as metal. [The addition of the hydroxylamine in this case not only ensures the complete separation of iron, whether it be present as ferrous or ferric, but it also entirely prevents the separation of manganese, which would otherwise partially fall out as brown hydrated oxide when the ammoniacal solution is exposed to air. The copper is reduced to the cuprous state, and mercury to metal; these reducing effects will also be brought about by hydrazine if the latter has been employed for the reduction of arsenic acid as mentioned above.]

The precipitate (3) is dissolved in concentrated nitric acid and mixed with excess of ammonia; in this way the mercury is retained in solution as a complex salt, mercuri-ammonium nitrate, and the other metals (Fe, Pb, Bi, Al, Cr), are again precipitated. The latter are separated and identified in the usual manner; the bismuth as oxychloride, lead as sulphate, iron and aluminium as hydroxides, and chromium as chromate. For the oxidation of chromium in alkaline solution the author employs potassium percarbonate, which not only keeps better than hydrogen dioxide, but is also more economical.

From the ammonia-hydroxylamine filtrate after acidification (3) the copper, which now exists as complex cupro-ammonium salt, is precipitated as sulphocyanate or as iodide (if the arsenic acid reduction has been gone through the cuprous iodide will, of course, separate on merely acidifying this solution); ammonia and ammonium sulphide are then added, which precipitates manganese, zinc, cadmium, nickel, and cobalt as sulphides. These are dissolved in aqua regia, the excess of acid removed, and the solution mixed with soda and hydrogen dioxide, or, better, potassium percarbonate. Zinc now remains in solution as zincate, and the remainder are precipitated as $MnO(OH)_2$, $Co(OH)_3$, $Ni(OH)_3$, or $Ni(OH)_2$, and $Cd(OH)_2$. Percarbonate is here advantageous, since the nickel comes down as dark brown nickelic hydroxide, which is easily filtered and washed. The further separation is conducted on the usual lines.

The filtrate (10) from the ammonium sulphide precipitate contains arsenic as sulpho-salt (unless arsenic was initially removed), and the other metals—magnesium, barium, strontium, calcium, potassium, and sodium as chlorides, &c.; on acidification with hydrochloric acid the arsenic separates as sulphide, and the solution is examined for the remaining metals in the usual manner after destroying the excess of ammonium salts.

A glance at the subjoined table, which is an abbreviated form of the one given by the author, may serve to indicate the essential stages in this new scheme of separation.

Evaporation with concentrated nitric acid.

Residue (1) **Sn. Sb.** | Solution (1) Fe. Pb. Bi. Al. Cr. Hg. Ag. Cu. Mn. Zn. Cd. Ni. Co. As. Mg. Ba. Sr. Ca. K. Na. Removal of phosphoric acid. Removal or reduction of arsenic acid. Addition of hydrochloric acid.

Precipitate (2) **Ag.** | Solution (2). Addition of hydroxylamine hydrochloride, and excess of ammonia.

Precipitate (3). Fe. Pb. Bi. Al. Cr. Hg. Dissolution in excess of nitric acid and precipitation with ammonia.

Solution (3). Cu. Mn. Zn. Cd. Ni. Co. (As). Mg. Ba. Sr. Ca. K. Na. Acidification with dilute hydrochloric acid and addition of ammonium sulphocyanate or iodide.

Precipitate (4). Fe. Pb. Bi. Al. Cr. Dissolution in hydrochloric acid and dilution with water.

Solution (4). **Hg.**

Precipitate (5). **Bi.** | Solution (5). Pb. Fe. Al. Cr. Addition of dilute sulphuric acid.

Precipitate (6). **Pb.** | Solution (6). Fe. Cr. Al. Addition of Soda and potassium percarbonate (or H_2O_2)

Precipitate (7). **Fe.** | Solution (7). Cr. Al. Addition of Ammonium chloride.

Precipitate (8). **Al.** | Solution (8). **Cr.**

Precipitate (9) **Cu.** | Solution (9). Addition of ammonia and ammonium sulphide.

Precipitate (10). Mn. Zn. Cd. Ni. Co. Dissolution in aqua regia and addition of soda and potassium per-carbonate (or H_2O_2)

Solution (10). (As). Mg. Ba. Sr. Ca. K. Na. Acidification with dilute hydrochloric acid.

Precipitate (15). **As.** | Solution. Mg. Ba. Sr. Ca. K. Na. Separated by the ordinary methods.

Solution (11) **Zn.** | Precipitate (11). Dissolution in hydrochloric acid and precipitation with ammonia and hydrogen dioxide.

Precipitate (12). **Mn.** | Solution (12). Cd. Ni. Co. Evaporation with nitric acid to destroy ammonium salts. Dissolution in hydrochloric acid (examination of a portion of solution for Co by potassium nitrite) addition of soda, potassium cyanide and ammonium sulphide.

Precipitate (13). **Cd.** | Solution (13). Ni. Co. Oxidation by air to cobalticyanide and precipitation with bromine water as usual.

Precipitate (14). **Ni.** | Solution (14). **Co.**

NOTE.—Residue (1) may also contain Sulphates of Pb. Ba. Sr. Ca. It is examined in the usual manner.

THE editors of the *Geological Magazine* (Dr. Henry Woodward, F.R.S., and Dr. H. B. Woodward, F.R.S.) held a reception on Thursday, February 8, to commemorate the publication of the 500th number of the magazine. The rooms at No. 5, Johnson Street, Notting Hill Gate, W., were well filled, and many ladies and distinguished men of science gladly responded to the invitation. Excellent music, vocal and instrumental, was provided, and geological photographs and drawings were exhibited. We trust the *Geological Magazine* may long continue its most useful work.

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The Eolithic Controversy.

BY J. RUSSELL LARKBY.

THE recent renewal of the controversy on the nature of Eoliths (*Man:* Anthropological Inst., Oct., Nov., and Dec., 1905) has had the result of awakening further interest in the question of the authenticity of these forms as illustrating a pre-Palæolithic period of man's progress. As suggested in my note in "KNOWLEDGE" for October, 1905, p. 252, it is necessary for the objectors to the artificial origin of these forms to show that the mechanical process of Mantes in any way resembles the natural method by which the plateau or any other gravels were laid down.

On December 19, 1905, Mr. S. Hazzledine Warren, F.G.S., read before the Anthropological Institute a paper on this question, in which he attempted to show the purely natural origin of these forms. In illustration of his contention Mr. Warren made several pseudo-Eoliths, which were handed round for the inspection of his audience. The mechanical process in this case took the form of a screw press, in the lower jaw of which was a small circular pit; two stones were placed in this receptacle, and on pressure being applied, the flints were fractured in a way which certainly, to some extent, resembled Eolithic implements. Whilst congratulating Mr. Warren on the ingenuity thus displayed in support of his contention, it is impossible to give assent or support to his deductions. I should characterise this process as an artificial method of the most pronounced type; it rests with its originator to prove that any legitimate comparison can be drawn between the screw press and natural deposition. Mr. Warren eliminated two most important factors in his experiment; in the first place, the presence of water under natural conditions must very materially reduce the intensity of any blows received by the stones when undergoing free rolling in a river bed; secondly, the hard, rigid bed of the screw press has no similarity to the soft and muddy floor of a river channel, hence the blows received by flints in the process of rolling would again undergo a considerable diminution. I would again emphasize the fact that in the plateau gravels there are forms which are not only definitely chipped, but are almost wholly unabraded by transport; others, however, show the work obscured by subsequent rolling, and to some of these highly-worn examples exception might well be taken if they were not accompanied by the unworn forms. It may, however, be objected that the very presence of the chipped edges is indicative of natural action, and this obviates the necessity of supposing man's presence here during the deposition of this drift. To this it may be answered that those flints with slightly abraded edges bear very few insipient cones of percussion on their flatter surfaces; therefore, if the chipping is purely natural, the process of rolling was confined entirely to certain areas of the stones. This hypothesis will not commend itself to students of the question save as a *reductio ad absurdum* of the natural origin theory, and yet it is the conclusion to which our opponents are forced if they persist in attributing these forms to some agent other than an intelligent being. Mr. Warren's contention seems to be that as the results of certain mechanical methods of the present day closely simulate man's work in the past, *ipso facto*, man has never produced them at all; but to produce such forms by an essentially artificial method, and then to assert that in the past they could only be the outcome of natural action seems to me to be illogical. Mr. Warren's answer to the claim that Eoliths are shaped according to definite types, is that the shape is governed by the existence of lines of weakness; therefore, the matter of definite type is simply the natural result and proof of such lines of weakness. The argument is pleasantly attractive from a purely theoretical point of view, but it is essentially a case of assertion arising from assumption. It is necessary to prove the existence of these lines of weakness where they would be least expected, *i.e.*, the thickest parts of the flints, for some Eoliths in my collection are as well chipped at the base as at the thin edge.

To the "creep" of frozen and partially frozen soils and gravels Mr. Warren would assign some types of Eoliths; but here, again, is very debatable ground. My own observations in the area of the Darent and Cray lead me to believe that in this instance very little post-deposition movement has taken place; as the only site at which there is clear evidence of frozen conditions is a small plateau carrying a high level Darent gravel, the "creep" must have been of an insignificant nature —hopelessly insufficient, it may be suggested, to shape and chip the definitely-formed and striated Eoliths found there. To those who have devoted their time to practical investigation in the field and to careful classification at home, it may seem inconceivable that the definite and classifiable types of plateau flints are merely the result of fortuitous batterings; save on the theory of intelligent design, it is difficult to believe that certain forms would be repeated over and over again and attained by a remarkable similarity in the type of work and the angle of chipping.

All students of this interesting question are indebted to Mr. Warren for his careful paper, and if it fails to obtain the elimination of Eoliths from the field of science, it will at least show the crying need for greater care in the admission of indefinite evidence in support of our claim. There can be little doubt that even in England flints have been admitted as evidence which should have been left in the field or consigned to the heap of rejected forms in the garden. When, however, it is said that in the gravels of St. Prest 80 per cent. of the flints are considered as either "utilised or retouched,"* it is impossible to refrain from raising the cry of "Siste, viator."

To Make Iron Grow.

To the Editors of "KNOWLEDGE & SCIENTIFIC NEWS."

SIRS,—In your January number, page 330, you have a short notice under the above heading, showing that iron by repeated heating to a critical temperature and cooling can be made to expand in cubical dimension to 46 per cent. of its original size. No theory except the globular molecular theory can account for this.

The globular molecular theory is this. That the molecule in gases and liquids is a hollow globe, and in solids a variously shaped hollow mass, all with their inner spaces

*Dr. Hugo Obermaier, in *Man*, 1905, Art. 102.

occupied with æther; that the molecules are in touch with one another and occupy all the space that gravitation (pressure) permits; that the only other force acting on the molecules is that form of gravitation named cohesion; that the cohesion that acts on a molecule by contact with its neighbours is greater, because of the interior space, than the cohesion tending to solidify the molecule; that the molecule consists of superposed globular shells of the elements that compose it; that that expands the molecule by entering it as vibrating æther which expends its vibrations in the work of expansion and thereafter remains as what is called latent heat; that when the contained æther leaves the molecule by the need to level, or, as it may be called, equalise itself, it is thrown into vibration and appears as radiant heat.

The heating of the iron makes its crystalline molecules expand and approach the globular shape. There are then small spaces among the molecules that there need not be in the cold mass if the crystalline shapes are perfectly arranged together. The æther in these small interspaces in the hot mass is in violent vibration, and this motion, in addition to the production of radiant heat and light, is some of it expended in displacing the crystalline molecules, with the result that the mass is increased in dimension.

No theory that includes flying atoms can explain this expansion of the iron.

W. F. BADGLEY.

February 4, 1906.

Answers to Correspondents.

Mock Suns. — W. H. C. sends an account with sketch from Canada of "Sun Dogs," and asks the cause of the phenomenon.

These "mock suns" have for long been well known. Most books on meteorology refer to them (*e.g.*, Hartwig's *Aërial World*). Similar phenomena have been described in many accounts of Arctic or Antarctic regions (Capt. Scott in the *Voyage of the "Discovery"* gives a coloured illustration of one). The effect is caused by the polarisation of the light on striking the small crystals of ice suspended in the air.

The Star towards which the Earth is Travelling — A. F. M. asks whether this star is visible to the naked eye, and what size it is as compared to Sirius. The whole solar system is moving in the direction of Vega, a star of the 1st magnitude. This is proved by the fact that the stars in this neighbourhood are gradually opening outwards, while those in opposite direction are closing together. Vega appears smaller than Sirius, the relative magnitudes being 0.1 and 1.4 respectively.

Occultation of Star by the Moon. — T. A. Lowndes writes describing accurately the "strange sight" he saw on February 3 at 20 minutes past 5. A small star was close to the moon and appeared to be *in front* of the dark part of it. It disappeared at 27 minutes past 5. Under the "Face of the Sky" in our February number one may see that on February 3 at 5.23 the first magnitude star Aldebaran was in occultation with the moon. The bright star close to the edge of the dark portion of the moon would be very liable to have the appearance of being in front of it. Several smaller occultations occur this month (*vide* "Face of the Sky").

Frogs found in Rocks. E. Braddock asks for information respecting the alleged finding of live frogs in rocks. Mr. Frank Buckland went into this subject many years ago, and the conclusion that he came to was that in every well authenticated case it was found that some crack or other means existed by which the frog could obtain air and probably insect food. Though such reptiles undoubtedly live to a great age, it seems probable that in these cases the frog or tadpole may have become caught in some crevice, and bit by bit have worn a larger hole for itself as it grew.

Photography.

Pure and Applied.

By CHAPMAN JONES, F.I.C., F.C.S., &c.

The Colour Sensations.—There are various opinions as to the principles upon which colour photography should be based. Some consider that four colours are necessary, others that three colours are sufficient, and that there is considerable scope for choice in the selection of the three, but there can be no doubt that the present position of colour photography, if not its very existence, is largely due to endeavours to record separately the colours that correspond to the three sensations, so that these may be stimulated by the various parts of the finished photograph in the same proportions as by the corresponding parts of the original. From this point of view the colour sensations are of prime importance to the photographer.

Since 1899 Sir William Abney has been engaged in revising the details that he then published, expressing the three sensations in terms of luminosity, and he has lately published the results of his work. He has obtained results that were impossible before, by a modification of his well-known colour-patch apparatus. Light from an arc lamp is passed through a train of two prisms, and then by means of a semi-silvered mirror a part is diverted, and so two spectra are formed, each of which is received on a plate with three adjustable slits in it and a lens beyond for combining the transmitted lights to form a patch. Thus on the screen two adjacent adjustable colour patches are formed, and also a patch of white light obtained by a mirror by reflection from the first face of the first prism. The luminosities of the patches of light are regulated for photometric purposes by revolving sectors as usual.

A re-determination of the sensation curves by means of this more efficient apparatus, in conjunction with other experiments, leads to the conclusion that there is no fourth sensation excited by violet light, as has been suggested by Burch. The revised curves show only slight alterations from those previously given, and this chiefly in the green, where the three sensations overlap and give an admixture of white with the predominant colour. The curve of this "inherent white" shows no sudden rise in any colour as was represented in the curves previously given. The amount of blue sensation in the yellow and green of the spectrum has also been corrected. Full tables and curves, and a description of their applications in three-colour photography, are given in the Philosophical Transactions of the Royal Society (series A, vol. 205, pp. 333-355). The paper can be obtained separately from Messrs. Dulau, of Soho Square, for one shilling.

The Bleaching-Out Three-Colour Process.—The principle involved in this method of reproducing colour by exposure to light of the prepared material under the original is of a very simple character. The three necessary colours are contained in the sensitive film, and on exposure the colouring matter that absorbs light is bleached while that that transmits the light remains, or, at least, remains longer than the others. Red light, for example, or the light that passes through the red parts of the original, being transmitted by the red dye has very little effect upon it, but it is absorbed by the blue and yellow dyes bleaching them, and leaving a red

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colour in the print that corresponds with the red of the original. The difficulties of working out such a method are such that they might well be regarded as insurmountable. The three dyes must not only be of the correct tints, but they must be fugitive enough to be bleached by an exposure to light of a reasonable duration, and, after the print is made, they must be permanent enough to be but little affected by ordinary light. It is sought to secure these opposing qualities by adding materials that induce a temporary sensitiveness, and removng them when the print is made.

Jan Szczepanik has overcome these difficulties so far that the firm of J. H. Smith and Co., of Zurich, are preparing to issue the sensitive material commercially. At the exhibition of colour photographs arranged by the editors of the *British Journal of Photography* at their offices, and which is just about to close, there are a few very striking examples of this process, copies of "lithophanes," that is, the coloured material sometimes used for window decoration. The colours in the copies are very clean and bright. Of course, the large flat patches of crude bright colours in the originals are not so severe a test as more delicate neutral tints, and as the originals are not exhibited it is impossible to tell whether the colours of it are fairly matched in the copies, but it is quite evident that bold colours of very various kinds have been obtained.

Mr. Coburn's Work.—There is an exhibition of the "Work of Alvin Langdon Coburn" at the house of the Royal Photographic Society in Russell Square, to which anyone is welcome, until the end of March, on presentation of his card. The exhibits are advisedly not called photographs, for we learn from Mr. Bernard Shaw in his preface to the catalogue that Mr. Coburn is very mixed in his methods, making gum prints, for example, on the top of platinum prints. When Mr. Shaw tells us that Mr. Coburn has "condescended to oil painting as a subsidiary study," we are led to expect excellent work in spite of Mr. Coburn's lack of experience, for he is a young man of only three-and-twenty. The series of some forty portraits is distinctly interesting. They are done in an unconventional style, and although a few of them appear to show a desire to be eccentric, some of them are very fine indeed, and well repay the trouble of a visit to see them. Of the eighty other specimens, Mr. Bernard Shaw appears to consider it necessary to make a sort of apology, for he tells us that Mr. Coburn's "impulse is always to convey a mood, and not to convey local information," but the author himself entitles the most of them by the names of places, streets, bridges, and so on. For my part I cannot imagine them "conveying moods" of a pleasant or satisfactory kind to anyone; their detailless flat patches, extreme want of definition, and the absence of a sense of due proportion, are distinctly unpleasing, and the representations of places that I know are useless as reminders. If these pictures were not put forward as serious work—and I suppose that they are meant to be taken seriously—I should have thought that they were a beginner's attempts, with here and there a promise of better things in the future if the maker of them considered it worth while to persevere. It is difficult to believe that these "works" and the portraits in the other room are by the same author.

Received.—The Thornton-Pickard Catalogue for 1906 is to hand, and besides the well-known specialities of the firm, it includes a new pattern of the "Royal" shutter, that is, the roller-blind shutter with the mechanism inside the case, and a low-priced outfit called the "Imperial Perfecta."

REVIEWS OF BOOKS.

Our Stellar Universe. Stereoscopic Star-Charts and Spectroscopic Key Maps. Thomas Edward Heath. (King, Sell and Olding, Ltd.). (26+vi. with 26 plates and 26 stereograms.) 10s. net.—Changing his view-point, Mr. Heath, instead of imagining himself at a distance of many light-years from the Solar system, now endeavours to give a 3-dimension idea of the relative distribution of stars as seen from the earth, replacing the celestial sphere for this purpose by 26 regions, which for the purpose of the key maps are represented by tangent planes, one at each pole, eight round the equator, and eight each at latitude 45° north and south respectively. The corresponding stereograms by the introduction of measured discs, and an allowance for parallax 19,000 times greater than the truth, do represent a system hanging in three dimensions, and the effect is certainly much improved by the piercing of the stereograms to give the stellar appearance not evident on the prints. A special set on thick card is issued at 5s. (or 2s. 6d. to purchasers of the book). Authorities are given for the values used for parallax of the better determined stars; for others an average parallax according to spectrum-type is used, which, although it improves the appearance of the stereograms by admitting a larger number of stars, is open to criticism on account of the arbitrary assumption involved. This, however, is of no great consequence, as the scientific value of the stereograms is of much less importance than their popular interest. The spectroscopic key maps give full details as to the name, magnitude, spectrum-type, and parallax of the principal stars, and are meant to enable the purchaser to identify the objects represented in the stereograms, which look far less familiar than the actual stars in the sky. It is unfortunate that the endeavour to cultivate a sense of proportion, which is so often lacking nowadays, should be compelled to start with an exaggeration of such a magnitude as 1 to 19,000. But the fault is not with the author, whose device is to be commended for its boldness. It is possible that we shall see this principle of exaggeration carried even further, on the ground that the relative proportions are strictly preserved as under a high-power microscope, but the work of Mr. Heath goes as far as appears advisable in that direction. It should be remembered that magnifying the parallax 19,000 times does not mean observing with eyes 19,000 times the normal distance apart, but with eyes whose distance apart is 19,000 times the diameter of the earth's orbit, or about $3\frac{1}{2}$ billions of miles.

The Reconstruction of Belief, by W. H. Mallock (Chapman and Hall), price 12s. net.

This great work, by the author of "Is Life Worth Living," is somewhat disappointing. The enquirer after religious truth, the agnostic requiring enlightenment, the Catholic anxious for confirmation of his early teachings, all are likely to close the book with the feeling that they are not much the wiser than when they opened it. Yet it is all good reading and sensibly written, and if, after a study of it, we are not convinced as to the exact standing and meaning of modern religion, at all events our minds may be opened and our thoughts concentrated on many points well worth considering.

The author points out that at the root of Christianity are three doctrines, namely, that the universe is over-ruled by some supreme intelligence, who has for his special object the highest good of man; that each man is a self-directing personality, answerable as such to the supreme intelligence for his conduct; and that his life here derives an infinite importance from the fact that it will be prolonged and completed for better or for worse hereafter. He then adds that even those who are satisfied to let these doctrines go, are conscious of some sort of loss, and desire to find a substitute for them; whilst others are looking about for some means of defending them, which may justify them in retaining their faith. It is to this latter class that the present volume is addressed, and though they may derive some comfort and extract many useful ideas, we think it cannot be said that all doubts such as linger in many minds to-day will be eradicated.

The Religion of Woman, by Joseph McCabe, issued by the Rationalist Press Association (Watts and Co.; price 6d.).—This curious work, prefaced by some stirring remarks of Lady Florence Dixie, seems to infer that woman owes her present position of bondage and slavery to man entirely to "Superstitious Religion," that is, the word of the Bible. As soon as she chooses to give up a belief in this, she will be ready to throw off the yoke of masculine oppression. It is interesting to trace the position of woman in the various periods of history, and this is well detailed in the book.

Philip's Large Planisphere (G. Philip and Son, 6s. net).—Designed by H. Gewecke (and made in Germany). A large planisphere, this is 1 ft. 8 in. diameter, is useful, as showing more clearly the positions of the smaller stars, and the adjustment can be more accurate than with the more usual small size. But in this case, although "an attempt has been made to present a picture as closely as possible resembling the sky" it is in this respect not wholly satisfactory. Fourth magnitude stars are represented by small circles, which is decidedly confusing at first. While some of the constellations are indicated by allegorical figures in an inconspicuous grey, others such as Gemini, Aries, and Auriga are not thus depicted. In order to avoid encumbering the map, no lines of R. A. or declination are given, but positions are readily found by a graduated straight-edge, which can be adjusted to any point of R. A. marked on the circumference, while the declination is marked on this straight-edge. This large planisphere will undoubtedly be found a most useful addition to the amateur's observatory. —"K."

Historical and Modern Atlas of the British Empire, by C. Grant Robertson, M.A., and J. G. Bartholomew, F.R.S.E., F.R.G.S. (Methuen); price 4s. 6d. net.—This is a most useful and handy little atlas, specially prepared for students, but also likely to be of value to all those who wish to learn more of the great Empire to which they belong (or do not belong). The first few pages are devoted to a short but concise account of the British Empire, including an alphabetical gazetteer, tables of statistics, and index to names. Then follows a series of most interesting and well executed maps descriptive of the growth of the Empire at various periods in history. Maps of the world showing natural features, density of population, commercial development, &c., are given. Then a number of maps of England, Scotland, and Ireland, to show vegetation, coal and iron, industries, population, physical features, and political divisions. Numerous maps of India, Canada, South Africa, and Australia follow, and the atlas ends up with a table of the "Chronology and Expansion of the British Empire."

Divine Dual Government. A Key to the Bible, to Evolution, and to Life's Enigmas, by William Woods Smyth (Horace Marshall); price 6s.—The subjects which this book professes to cover are so appalling in their magnitude and "unknowableness," that we hesitate before lightly casting it aside with a few commonplace remarks. The author commences with a preface in which he explains that his own interpretation of the works of Darwin and Herbert Spencer are so different from the interpretation of them by other writers that he has "always attributed them to the direct teaching of the Spirit of God." Glimpses are taken of early history and the dawn of revelation. There is much that is of interest in comparing the words of the Bible with scientific theories. Some may think the perversion of Biblical words and phrases may be carried too far. Thus the word "day" in Genesis, with reference to the Creation, is often supposed to imply a very different period of time to that which we know as day. The author supposes it to mean 10 million years. But he clearly shows how difficult it is to arrive at any certainty when speaking of any such vast period. We can recommend anyone who wishes to investigate such subjects to study this book, although we would not say that personally we are at all satisfied with many of the conclusions arrived at.

The same author sends us a little pamphlet on "the Cost of Man's Creation and Redemption in the light of Natural Science," which is of much the same nature as the book.

The Theory of Experimental Electricity. (Cambridge University Press.) W. C. D. Whetham, F.R.S.; 8s. net. This text-book represents a course of class lectures delivered at Trinity College, Cambridge, and is intended to be a book of reference to which students may turn for further elucidation of points not clear to them. It is no mere cut-and-dried account of classical electricity, but aims at giving also "some insight into methods of research together with some idea of recent results, and of unsolved problems ripe for examination." The subject is thus presented as a living one, and this tends a great deal towards the making of a most interesting volume. But on the other hand the historical side is not neglected; in the case of the introduction of any fresh fundamental fact or principle, a brief but clear account is presented of the particular mode in which the fact was first learned. The chapters which will probably be turned to first by the reader who has already mastered the rudiments of the subject are those on conduction in gases and on radioactivity. So much of the new work on these questions has been done by the Cambridge School that we naturally look to it for a satisfactory exposition of it, and we are not disappointed. Further, the text is exceedingly well printed and the diagrams are wonderfully clear.

The Scientific Roll and Magazine of Systematised Notes. Bacteria. Conducted by Alexander Ramsay. Published by R. L. Sharland, 38, Churchfield Road, Acton, W.; 1s.—This quarterly magazine has now ceased to be a mere recording roll of classified Bacteria. Useful, as it no doubt was, to a limited number of students, it may now claim a wider interest by reason of its containing readable matter. The conductor, wisely we think, promises in future numbers to introduce bacterial studies bearing on the problems of Health and Agricultural Economy. A more than something is known of the Bacterial Causation of Human disease, and our knowledge is rapidly extending. The same cannot be said of the Bacteria of the Soil; agriculturists know nothing of the bacterial invasions leading to the birth, growth, and decay of crops, &c., or of those producing disease in the same. Mr. Ramsay promises to enlighten us in this work on these problems, among others, and so benefit scientists in particular and mankind in general. This is the fourth year of the "Roll's" existence. Under its new development it promises to have an extended and successful future.

S. G. M.

An Introduction to the Infinitesimal Calculus. Dr. H. S. Carslaw (Longmans; 5s. net).—This book is written specially for 1st-year science and engineering students by the Professor of Mathematics in the University of Sydney. The object has been to present the fundamental ideas of the Calculus in a simple manner, and to illustrate them by practical examples. It will prove a very useful little book for use, especially in technical schools. Although rigorous proofs are as a rule avoided, there is little in the book which anyone would need to unlearn on going on to a higher stage. We commend it also to anyone who wishes to teach himself the elements of the Calculus as being very clear and likely to help him over the difficulties which beset the private student in his initial attempts to tackle this somewhat formidable but fascinating and important subject.

Leather for Libraries, by E. Wyndham Hulme, J. Gordon Parker, A. Seymour Jones, Cyril Davenport and F. J. Williamson. Published for the Sound Leather Committee of the Library Association (Library Supply Co.); 1s. 6d. net. This is an important little work, since every book-lover wishes to know what is the best material with which to bind his volumes, and many, sorrowfully noting an unexplained deterioration in their bindings, are most anxious to know the cause and remedy. Here is a practical and unbiassed account dealing with the technics of leather, and clearly setting forth the causes of decay, the methods of preparation, and the most suitable kinds of leather for bookbinding.

Machine Construction and Drawing, by Frank Castle (Macmillan) 4s. 6d.—This is a useful guide to students and others to learn the practical details of machinery with the object of making working drawings. Such details as rivets, bolts and nuts, shafting, belt pulleys, bearings, pipe joints, and parts of engines are fully described with specimen drawings.

We have received a new catalogue of telescopes, &c., by Messrs. R. and J. Beck. This includes many instruments suitable for the amateur astronomer, especially 3-inch telescopes, and various stands and mountings. There are also astronomical cameras, microscopes for star photographs, diffraction gratings, theodolites, and other instruments.

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NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Recent Work on Sunspot Spectra.

Two important papers dealing with the special features of the sunspot spectrum have recently been published. W. M. Mitchell, observing at the Princeton Observatory (which has been rendered notable by the work of Professor C. A. Young on the solar chromosphere and spots), has given a long list of specially affected lines, an analysis of which confirms the interesting results of previous observers that most of the chief lines concerned are due to the rare elements vanadium, titanium, and some unknown elements. Many of the chief lines were observed as reversed, giving bright centres to the lines.

G. E. Hale furnishes a long list of lines observed in the spectra of spots photographed with the magnificent equipment lately installed at the Solar Observatory on Mount Wilson in California by the Carnegie Institution. The beautiful illustrations accompanying the paper will convince many who may still have lingering doubts as to the reality of these specialised phenomena of the sunspot spectrum. In the analysis of the lines observed, the lines chiefly affected are ascribed to titanium; then come lines of manganese, chromium, calcium, iron, nickel, and cobalt. It is specially noticed that all of the lines of silicon in the region examined are much weakened. Many of the "*spot band*" lines have been photographed and are identified with faint lines in the Fraunshoferic spectrum.

Variation of the Figure of the Sun.

From a further examination of solar measurements made by Schur and Ambronn with the heliometer at Göttingen during the period 1890-1902, C. L. Poor has obtained more evidence in confirmation of the reality of the variations of the sun's figure which he put forward a short time ago. These later measures cover a whole sunspot period of 11 years, and they show a decided periodicity, the polar diameter being larger in 1890-1, while the equatorial diameter was greatest during 1892, 1893, and 1894. The exact length of the period is uncertain, but it appears to be nearly the same as the sunspot period. The amplitude of the variation is about $0''{\cdot}2$; the difference between the largest positive and negative values being about $0''{\cdot}5$. These heliometer measures thus corroborate the conclusions previously determined from Rutherford's photographs, but the amplitude of the variation is much less in the case of the visual observations.

New Astrographic Refractor for Cincinnati Observatory.

We hear that the Cincinnati Observatory has recently placed an order with Messrs. T. Cooke and Sons, of York, for one of their triple photovisual astrophotographic objectives. The aperture of the new lens will be 9·5 inches, and its focal length 67·7 inches, so that one millimetre on the photographic plate will be equivalent to two minutes of arc, this scale being half that of the International Astrographic series of negatives.

It will be noticed that the ratio of aperture to focal length, or intensity, of the new lens is 1:7, much greater than the usual ratio of 1:18. Moreover it is confidently stated that the objective will give good definition over a field fully 15° in diameter, and so should prove specially satisfactory for photographing comets, nebulæ, and asteroids. This new photographic equipment will be attached to the tube of the old 11-inch refractor, at present mounted in the Mitchell Memorial Building.

Annular Nebula in Cygnus.

M. G. Tikhoff has recently communicated to the *Comptes Rendus* an account of a series of photographs of nebulæ he has obtained at the Meudon Observatory. Some of these show very interesting details of the Annular Nebula in Cygnus, N.G.C. 6894. They were taken with a telescope of one metre aperture and three metres focal length, with exposures from $2^h\ 20^m$ to 3^h, on September 27 and October 27, 1900, respectively. The nebula is in the form of an elliptical ring with a central condensation. The major axis is about $44''{\cdot}8$, and the minor axis $37''{\cdot}3$, It is composed of two rings, an exterior broad one and an inner portion somewhat thinner. On the north-west portion the doubling is interrupted by the presence of the star discovered by Lord Rosse in 1855. On the outer ring there are several condensations, of which the two strongest are almost opposite the above-mentioned star. Although the general similarity of this nebula to the well-known and brighter Ring Nebula in Lyra is noticeable, it differs in possessing these condensations, while the Lyra nebula is almost uniform in structure; and it is thought that this circumstance indicates a considerable advance of the Cygnian body from the evolutionary standpoint.

Occultations of Aldebaran.

On March 2nd and 29th the occultation of the bright yellow star Aldebaran will offer facilities for several interesting observations. Those possessing small telescopes up to 4 ins. aperture should look specially for the small companion, of about the eleventh magnitude, which is considered a good light test for instruments of this size. It is within $2'$ of arc in distance from Aldebaran. The other minute attendant star found by Burnham about $31''{\cdot}4$ distance is not considered to be physically connected with the Aldebarian system. At various previous occultations of Aldebaran observers have recorded a slight tendency for *projection*, or hanging-on, of the star. Although this might be caused if the companion star were brighter, it is doubtful if it be real, and observations carefully made to solve this question would be welcomed.

Harvard College Observatory, Report for 1905.

In his report for the year ending September 30, 1905, Professor E. C. Pickering has again an enormous amount of work to record. With the East Equatorial over 13,000 photometric light comparisons have been made by Professor O. C. Wendell, principally with the polarising photometer with achromatic prisms. A large part of these relate to variable stars of the Algol type, and serve to determine their light curves and times of minima. Measures have been made of four Asteroids, to determine the variation, if any, in their light. Thus from 1580 determinations of Eunomia (15) it appears that this asteroid varies by about half a magnitude in a period of $3^h\ 24{\cdot}5^m$. With a second photometer, measures have been made of the remarkable variable O Ceti and several double stars.

With the 12-inch meridian photometer, 81,284 settings have been made by the Director, on 148 nights. The measurement of all the Durchmusterung stars in zones 10′ wide, at intervals of 5°, has been completed from the North Pole to declination $-20°$.

With the 11-inch Draper telescope, 1001 plates of spectra were taken, and 133 with the 8-inch Draper telescope. The number of photographs taken during the year is 6161. Eclipses of Jupiter's satellites and occultations of stars by the moon have been photographically recorded, and work is proceeding with the classification and study of the spectra of stars of about the fifth magnitude, during which study many interesting new variables have been detected.

In connection with modern observatories near, or in, large towns, a special inquiry has been made with regard to the photographic brightness of the sky. It was found that owing to electric lights, &c., the sky at Cambridge, Mass., is three times as bright as at points only a few miles distant, and it is suggested that it may be necessary in the future to establish an auxiliary observing station for the northern stars.

Stellar photographs at Arequipa were taken with the 13-inch Boyden telescope and the 8-inch Bache, to the number of 2244.

The Bruce telescope has been in full work, 523 photographs being obtained, of which 27 had an exposure of 4 hours. From a study of these, 1129 new variables have been detected, 909 being in the small Magellanic cloud. Other photographs led to

the discovery of Themis, the tenth satellite of Saturn. This is sometimes brighter or fainter than Phœbe, and the latter appears to be variable. The Blue Hill Meteorological Station has been maintained, as before, at the expense of Mr. A. L. Rotch. During 17 kite records of the upper air, the average altitude was 6940 feet, and the maximum height attained was 11,180 feet. With *ballons-sondes* a height of 48,700 feet was reached, the temperature recorded being — 111° F.

BOTANICAL.

By G. MASSEE.

Floral Colours and Pigments.

THE colours of flowers, from a biological standpoint, have received much attention during recent years, but, as a rule, the colour, as we ordinarily see and interpret it, has formed the main or only basis for comparison. In the *Journal of the Royal Horticultural Society* Mr. Bidgood has treated the subject from a different and more fundamental standpoint. Plants do not inherit colour from their parents, but the pigments which possess colour or colours as their most characteristic properties. Further, if a pigment is inherited it does not necessarily follow that the colour of that pigment should be of the same hue as that of the parent. A plant may inherit from one parent an uncoloured substance which, with a pigment from the other parent, as in the case of a hybrid, may modify the pigment so that the colour is altered. Finally, a hybrid may inherit an uncoloured substance from each parent, which may re-act on each other and produce a pigmented or coloured substance. It is indicated that knowledge of this kind should prove very useful to those interested in hybridisation and the production of new colour varieties of plants, as it would prevent much time being wasted, and a striving after the practically impossible. Students of Mendel would also benefit by devoting more attention to the inheritance of pigment, rather than to the inheritance of colour.

A flower is seen by the light given off from its surface, much of it after having penetrated to a greater or less extent, and after having been more or less decomposed by the pigments present in the cells. If the pigmented particles consist of green corpuscles or chlorophyll grains, underlying a red dissolved pigment, the chlorophyll would absorb nearly all the light that passed through the red solution, and little or none would reach the surface again. The result would be a dark neutral brown or black. The outer side of the flower of *Crocus aureus* has green stripes near the base. This colour is due to the combined effect of blue anthocyanin in the epidermal cells on that side, and to a yellow xanthic pigment on the other. The black blotches on the leaves of *Arum maculatum* are the result of crimson anthocyanin overlying green chlorophyll.

Subjective colours due to the interference of light in thin films, frequently seen in animals, does not appear to exist in plants.

Relations of the Algal Floras of the N. Atlantic, the Polar Sea, and the N. Pacific.

It has long been known that a great many plants in the northern hemisphere have a circumpolar distribution. Plants of the tertiary period occupying districts around the Pole were driven southwards to the Continents of our time during the glacial period, and on its cessation slowly wandered back to their original home. At the same time these plants left some of their representatives in their southern temporary home. By these means we account for those species which every Arctic district has in common with the mountains south of it, but not with other districts. This knowledge, however, only applies to flowering plants, and as far as marine algæ are concerned but little has been attempted in this direction previous to the work by Simmons in the *Botanischen Centralblatt*. In early tertiary times the Polar Sea possessed a distinct flora limited from the Atlantic flora by a land-bridge now absent. A similar barrier also separated the Pacific Ocean from the Polar Sea. On the disappearance of these barriers the Polar algæ invaded the Atlantic and Pacific, and the glacial period drove more algæ south, leaving the Polar Sea almost devoid of plant life. After the glacial period some algæ returned to their old home, and this condition of things is still in progress so far as conditions allow. Many of the tertiary Polar species have, however, not been able to return, owing to adverse conditions. As a result there are now some Atlantic and Pacific algæ respectively that had their origin in the Polar Sea, but are now absent from there. On the other hand, some old Atlantic algæ that became adapted to cold during the glacial period, migrated to the Polar Sea along with the returning original Arctic algæ. This theory accounts for the heterogeneous assemblage of types of algæ in the Polar Sea at the present day, and also for the presence of Arctic types in what are considered indigenous species in the Atlantic and Pacific Oceans respectively.

On the Occurrence of Starch and Glucose in Timber.

A point of much economic importance has been announced by Professor Kirk in the *Transactions of the New Zealand Institute*. Examination of a considerable series of worm-eaten wood of various kinds showed that in every instance such wood contained starch or an abundance of glucose, and it is for the purpose of feeding on these substances that the larvæ of beetles attack timber. In the case of white pine (*Podocarpus dacrydioides*) it is recommended that the trees be cut when the stored starch has been converted into soluble glucose, and the timber allowed to remain exposed for some time to the action of water to dissolve out the glucose.

Mycorhiza on Roots of Trees.

The presence of mycorhiza or growths of fungus mycelium on the roots of many plants has long been known, and various investigators, more especially Frank, consider that such growths are of great service, if not even indispensable to the nutrition and health of the plant thus infected. Transeau in discussing the flora of the bogs of the Huron River Valley, in the *Botanical Gazette*, expresses the opinion, founded on field observations, that in *Larix* mycorhiza are only developed when the ground in which the plant is growing lacks aeration, and more especially when the roots are surrounded by water. Acidity of the medium in which the plant is growing does not favour the development of mycorhiza. Whether the fungus is of actual advantage to a plant, even when growing in a poorly aerated soil yet remains to be determined. These conclusions corroborate those of others who have recently studied the subject, and point to the conclusion that the amount of importance attached to mycorhiza by Frank is exaggerated.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Poisonous Plants used for Catching Fish.

THE number of tropical plants which find a practical use in the catching of fish is very large, no fewer than 344 different kinds having been described by M. Greshoff. They belong to different families, but chiefly to the leguminaceæ, euphorbaceæ and sapindaceæ. The active chemical constituents to which they owe their toxic power are equally varied, and include alkaloids, glucosides, volatile oils, resinous bodies, prussic acid, etc. The compounds of most frequent occurrence have been found by Dr. Kobert to belong to the saponines, the best known example of which is found in the soap-wort, in the root of the clove pink, and in the horse chestnut. When extracted from these by means of boiling alcohol saponine is deposited as a powder when the solution cools. It is readily soluble in water, and the solution forms a lather like soap, whence the name of the compound. Dry, powdered saponine produces sneezing when inhaled. Another class of substances has been isolated by Dr. Greshoff and other Dutch chemists from leguminous plants belonging to the natural order *Derris*, and notably from the root of *D. elliptica*, which occurs in Java and the neighbouring islands, and has been especially studied by

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Herr Pabisch. They are all resinous bodies, free from nitrogen, apparently related to one another, and extremely poisonous to fish. The compound isolated from *D. elliptica* is termed *derride*, and has the formula, C_{33} H_{30} O_{10}.

The Distillation of Gold.

M. Moissan, to whom we owe so much of our knowledge of the behaviour of chemical elements at a high temperature, has found that there is no difficulty in distilling gold in an electric furnace, and that the liquid condenses on a cold surface in minute crystals and threads, which behave exactly like ordinary gold in a finely-divided state. The boiling point of gold is higher than that of copper or tin, but lower than that of lime; so that on distilling alloys of gold with copper or tin a fractional separation is effected, the gold being the last to pass over. When an alloy of gold and tin is distilled with lime, the distillate, consisting of a mixture of gold, oxide of tin, and lime, has the beautiful colour and other characteristics of the well-known *Purple of Cassius* used for colouring glass and porcelain. Hitherto this substance has only been produced by wet methods, such as treating a solution of gold in *aqua regia* with solutions of the chlorides of tin, and the new dry method of preparing it may be found of commercial importance. Deposits of other shades of colour can be obtained by mixing the alloy with silica, magnesia, alumina, or other oxides, in place of lime, before the distillation.

Flour Dust Explosions.

Fine, dry, organic dust, such as that of coal, flour, soot, or cotton, will take fire with explosive violence, and many terrible accidents have occurred in mines and mills through ignorance of this fact. After the explosion in the Haswell Collieries in 1844, the subject was investigated by Faraday and Lyell, who made recommendations as to better ventilation of the mines; but no precautions appear to have been adopted until later accidents led to the appointment of a Royal Commission. In 1872, a frightful disaster took place in the Tradeston flour mills, near Glasgow, but no one suspected the cause until Mr. Watson Smith showed that a mixture of flour dust and air would burn explosively in the same way as coal dust and air. An investigation made in 1881 by Messrs. Rankin and Macadam, brought to light the fact that many unexplained explosions had occurred in other flour mills, notably in Buda-Pest. These, too, were attributed to the dry flour dust having been ignited by sparks from the stone rollers, and the conclusion was arrived at that "it seems scarcely possible to guard against such accidents." Mr. Watson Smith has reviewed the whole subject in a paper read before the Society of Chemical Industry, and points out that to this day flour mills of the old type are still in use and are inevitably exposed to the same risks as the mills in 1881, notwithstanding the fact that means of obviating all danger were devised by Mr. Simon, of Manchester. These improvements consisted in replacing stone rollers by iron rollers, and in the introduction of what is known as the "Cyclone" System of collecting the flour dust. The dust-laden air from the rollers is conducted into a conical separator where, by means of the centrifugal action, the dust slides down the side to the bottom, and escapes through a small opening into a receptacle, while the air, freed from dust, is whirled upwards again, and leaves the "cyclone" through a cowl in the roof. In addition to the production of a purer flour, the method has the further advantage of preventing injury to the workpeople, who otherwise inhale the dust.

GEOLOGICAL.

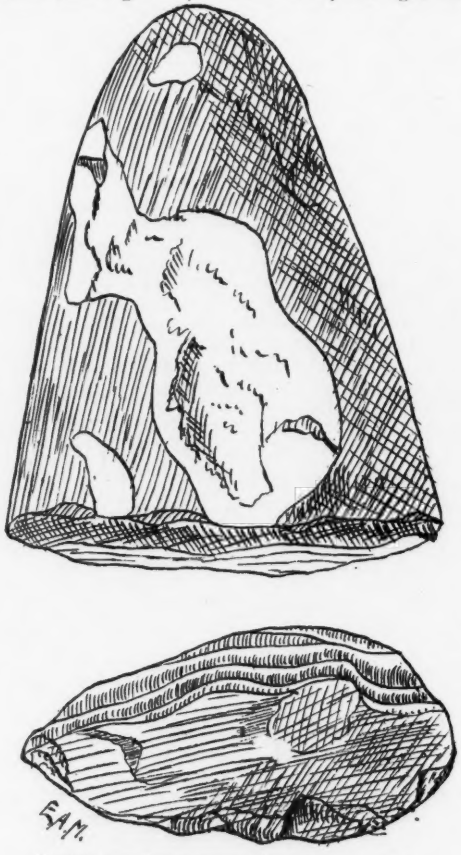
By EDWARD A. MARTIN, F.G.S.

Glacial Beds of Triassic Age.

THE Dwyka Conglomerate found at the base of the Karroo System in the Transvaal is now better known as the Glacial Conglomerate, since the former differences amongst geologists as to the nature of the formation have all but passed away. At one time it was generally supposed to have been of igneous origin, and great hesitation was naturally felt before accepting the glacial origin of the beds, situated as they are in a system which is certainly not younger than the New Red (Triassic). Mr. E. T. Mellor, F.G.S., has studied the district lying east of Pretoria to near Middelburg, and divides the Karroo rocks into an Upper and a Lower division. The former is sometimes known as the "High-Vela Series," and consists of various grits and shales with conglomerates and coal seams, whilst the latter consists of various glacial deposits, including the Dwyka Conglomerate, and associated shales and sandstones. The conglomerate averages about 50 feet thick, and may in depressions reach as much as 200 feet. The constituent boulders and sub-angular rock fragments show no definite arrangement, and lie in a confused mass. It is noteworthy that the surface of the older rocks underlying the glacial conglomerate are frequently polished and clearly striated, and also that the striæ exhibit a remarkable constancy of direction towards the south.

Neolith from South Norwood.

A portion of a neolithic flint implement has reached me which was found in a garden in South Norwood, on the slope of the hill below Grange Park. It bears a marked resemblance to one that was found by a workman in the Thornton Heath gravel pits some few years ago, and was



Neolith from South Norwood. (Natural size.)

referred to by Dr. A. E. Salter, F.G.S., in his paper before the Geologists' Association, entitled "Pebbly Gravels." The portion of an implement now found is well preserved, although on both sides a molecular change has proceeded in the silica, resulting in a banded appearance of the white portion when seen in section below. It is of excellent shape, and well polished.

Nilotic Geology.

The somewhat vexed question of the mutual relations of the Cretaceous and Eocene systems in the valley of the Nile has been to some extent determined by some useful observations which have been made by Mr. H. J. L. Beadnell, formerly of the Egyptian Geological Survey. In the autumn of 1904 he took advantage of certain opportunities which presented themselves to him to examine the desert margins

on both sides of the Nile Valley, between Aswan and Esna (lat. 24° to 25½°). Far from the Cretaceous and Eocene formations being here at all times unconformable with one another, there is distinct evidence that the passage from the oldest to the youngest beds was in some localities, notably near Ain Amur, so gradual that near the junction, fossils typically characteristic of Cretaceous beds in other places, occurred side by side with forms having distinct Eocene affinities. On the other hand, in the Baharia Oasis, the unconformity is most strongly marked. Of the Cretaceous beds, the Danian stage is clearly shown, whilst above these beds, and below the Lower Libyan (Eocene), Mr. Beadnell found it necessary to classify the Esna shales as passage beds, some 197 feet thick, since they undoubtedly bridge over the period which elapsed between the deposition of the Cretaceous white chalk and the incoming of the Nummulitic sea of Eocene times.

Ripple-Marked Sandstone Tiles.

With a plentiful supply of slates and tiles for the roofing of houses, the use of ripple-marked slabs of sandstone is not now, perhaps, so noticeable as formerly. Formerly the fissile slabs of Wealden sandstone, on which a long-ago incoming tide had left the impress of its ripples, were in great

demand, and many of the older Wealden farmhouses may be seen to be roofed with them. The illustration shows a farmhouse near Bletchingley, in Surrey, roofed with somewhat substantial sandstones, many of which are very clearly ripple-marked. These may be of Lower Greensand age.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

Bird Migration.

THE first Report of the Committee appointed by the British Ornithologists' Club for the study of the migrations of our British birds has just been published, and forms an exceedingly valuable contribution to our knowledge of this subject. The work began early in 1905 when schedules were distributed among a number of willing workers in England and Wales—to which areas the observations are to be confined for the present—and to numerous lighthouses and lightships. Over 15,000 records were received, and the report in question gives the results of the analyses of these.

The work for this year was confined entirely to the arrival and dispersal over the country of twenty-nine of our commonest summer visitors—the warbler, swallow, swift, nightjar, cuckoo, and land-rail being among the number.

It would seem from the report that, in some species, at any rate—as the whin-chat and chiffchaff—the birds which arrived first passed on northwards to nest, their place being taken by later arrivals; while the western and north-western counties of England were populated before the eastern and north-eastern.

Space, however, forbids a further summary of the results of the first year's work, which is full of most interesting facts, and should be read and studied by all who are interested in this subject. The great feature of this admirable digest are the maps which illustrate the movements of the species dealt with. Those who desire to obtain copies of the report should write to the publishers, Messrs. Witherby and Co., High Holborn.

Bittern in Essex.

The *Field*, January 20, records the fact that a bittern was seen within twenty-five miles of London on the 11th of this month. It was surprised by a sportsman in some sedgy growth "surrounding a large piece of water" and was, to his credit, allowed to escape unharmed.

Ferruginous Duck in Suffolk.

Two examples—sex not stated—according to the *Field* of February 3 were shot during the end of January near Bury St. Edmunds.

Wall Creeper at Ecclesbourne.

At the last meeting of the British Ornithologists' Club an example of the wall creeper (*Tichodroma muraria*) was exhibited which had been shot while climbing about the face of the cliff at Ecclesbourne, near Hastings, on December 26, 1905. It proved, on dissection, to be a female. This makes the fourth occurrence of this bird in Great Britain.

Dusky Thrush in Nottinghamshire.

At the meeting of the Club just referred to an example of the dusky thrush (*Turdus fuscatus*) was exhibited, which had been shot by a market gardener near Gunthorpe in October, 1905. This makes the first recorded occurrence of this bird in these islands.

Fire-Crested Wren.

There was also exhibited a male example of the fire-crested wren (*Regulus ignicapillus*), which had been shot at Wimbledon, December 31, 1905. This marks the first occurrence of the bird in Surrey. Another example, also a male, was exhibited by Mr. W. R. Ogilvie Grant, which had been picked up in a dying condition at Abbey Wood, Kent, January 10, 1906.

An Abnormal Eider.

A more careful scrutiny of our eider ducks would seem to show that occasionally at least specimens occur with a more or less distinct V-shaped mark on the throat hitherto supposed to obtain only in the Pacific eider. An example of this kind was exhibited at the meeting above referred to by Mr. Howard Saunders, which had been killed on December 7, 1905, near Stromness, Orkney. Whether this peculiar mark is the result of a cross with the Pacific species which occasionally occurs in our waters, or is independently developed, it is impossible at present to say.

PHYSICAL.

BY ALFRED W. PORTER, B.Sc.

Do Röntgen Rays Disintegrate Atoms?

ALL substances when illuminated by Röntgen rays or by Becquerel rays of the γ type give out a complex secondary radiation, part of which at least is wholly different in character from the primary radiation. For example, the secondary radiation due to the absorption of Röntgen rays consists in part of negatively charged corpuscles or electrons, although no such charged particles exist in the exciting rays. This suggests that there may be some breaking up of the substance upon which the exciting rays impinge—a disintegration of the same type as that which takes place spontaneously in radio-active substances. On the other hand, the production of streams of electrons by no means proves that such disintegration is a fact; for according to modern theories of electric conduction there exist numerous electrons in a conductor—and what substance is not a conductor?—which are only

loosely attached to the atoms and not apparently forming an integral part of them. They seem to float about very much as the particles of gas dissolved in a liquid. The electrons which leave the substance under the action of Röntgen rays may simply be these unattached ones, and if so the existence of the streams is no proof of atomic disintegration. This question has recently been tested by Professor Bumstead (working in the Cavendish Laboratory), who argues that if disintegration is brought about there must be a corresponding release of atomic energy, which will appear—in the main—as heat, and which will raise the temperature of the substance. For equal absorption of Röntgen rays the amount of heat produced from two substances might be expected to depend upon the material and be greater in amount than that of the incident rays, which merely play the part of a trigger. But if no disintegration occurs the heat produced should be equal to the energy of the incident radiation (minus the small amount carried away by the secondary radiation), and should therefore be practically the same in both cases. The experimental method employed is based upon these considerations. It is in brief a sort of reversed radiometer. A radiometer—such as was first devised by Crookes—acts owing to the incident light warming the vane which is repelled by the forces in *the air* between the vane and the fixed wall of the tube. It comes to the same thing if the wall itself is warmed while the vane is made transparent so as to keep cool. The latter arrangement was most suitable in the present case. The walls can be made of the metal under investigation, and the movement of the suspended vanes is due to the warming of the walls by Röntgen rays, and is a measure of the heat produced.

Only lead and zinc have been experimented upon so far. Their thicknesses were chosen so that they absorbed the same amount of radiation, and under these circumstances the experimental result is that about twice as much heat is generated in the lead as in the zinc.

Professor Bumstead examines the numerous sources of error to which the mode of experimenting is subject; and also other modes of explaining this difference in heat production; but concludes that the evidence is in favour of the view that true atomic disintegration is brought about by the absorption of Röntgen rays. The experiment is, however, beset with pitfalls, and physicists will probably await the results of further experiments, which are promised, and in which it is proposed to employ other means of measuring temperature, such as a thermopile. Anyone acquainted with the vagaries of a radiometer will regard with caution the conclusions arrived at from these preliminary experiments, even though he may be willing to grant their plausibility.

("PHILOSOPHICAL MAGAZINE." Feb. 1906.)

Conductivity of the Vapour from a Mercury Arc.

The Hon. R. J. Strutt showed some years ago that mercury vapour under ordinary conditions is a very perfect non-conductor of electricity. C. D. Child, in a recent paper read before the American Physical Society, shows that the vapour coming from a mercury arc is highly conducting. A luminous space gradually spreads out from the arc, and the front of this region has the greatest conductivity and the greatest luminosity. He considers that the conductivity is not due directly to ions coming from the arc, nor to rays sent out by it, nor to leakage over the surface of the glass, and probably not to the high temperature of the gas. He suggests as probable an explanation given by Merritt, viz., that when ions recombine they are at first in a condition of unstable equilibrium much like the atoms of radioactive matter, and that many of these combinations break up again into positive and negative ions.

The Efficiency of a Welsbach Mantle.

A fresh study has been made by Rubens of the light from a Welsbach mantle with the object of elucidating the reason of the extraordinary efficiency of this source of light. The fact that the small addition of cerium oxide (·8 per cent.) to the thorium oxide which forms the main body of the mantle (99·2 per cent.) enormously increases its light-giving power has induced many—especially among chemists—to regard the light as being essentially of phosphorescent origin—*i.e.*, as depending in the main upon chemical changes (or catalytic action) rather than upon the high temperature to which the mantle is raised. It is well known that at a given temperature, the radiation which depends upon temperature can never exceed that from a "perfectly black body" at the same temperature. Since a mantle without ceria and one with it give out very different light when placed in the same Bunsen flame, the assumption that the additional light is not due to the temperature has at least some plausibility. But nothing except a thorough study of the radiation can suffice to settle this interesting question. For there is a tacit assumption amongst the holders of the chemical theory that the two mantles placed successively in the same flame will have the same temperature. It is clear, however, that if one radiates much *more* than the other it will necessarily adjust itself to a *lower* temperature; for it is the gradient of temperature from the flame to it which controls the flow of energy to the mantle and which maintains this mantle at a constant temperature in spite of its radiation. The one that radiates most has to receive most, and a greater gradient is necessarily required to keep up the supply. Those who claim that no chemical change is responsible for the light assert that the more luminous mantle owes its luminosity to the fact that at a given temperature it is *a bad radiator for that temperature;* but that owing to this parsimony it is able to keep *at a higher temperature* than its more generous companion; and everyone is agreed that a higher temperature tends to produce greater efficiency.

The upshot of Rubens' measurements is that a mantle stained with iron oxide (and therefore a good radiator at a given temperature) kept at a temperature of about 1050° C. in a flame; whereas the unstained mantle rose to about 1500 C., while the estimated value of the temperature of the bunsen flame itself is about 1800° C. After making allowance for the non-continuous nature of the surface of the mantle, it is shown that *for no wave length* is the radiation as great as that from a perfectly black body at the temperature of 1500° C.; and that the total energy radiated is only one thirty-third part as great as from such a body. Although then it cannot be denied that phosphorescence may play some small part, yet it is altogether unnecessary to call in its aid to explain the amount of radiation.

Experiments on a mantle of pure thorium oxide show that the radiation from it contains almost no light rays, but in other respects is very nearly the same as for an ordinary mantle. On the other hand, a mantle of pure cerium oxide gives out radiation proportionately very rich in luminous radiation, and also of radiation of *very* long wave length. For the important region of wave lengths immediately in the infra-red (*i.e.*, $\lambda = 1$ to 8-millionths of a metre) it is a bad radiator. It would not do, however, to use such a mantle, for its temperature (like the iron-oxide one) keeps very low. But the addition of a small amount of ceria to thoria much increases the luminous radiation of the latter without sensibly alterating the radiation in the immediate infra-red. Thus the behaviour of an ordinary mantle can be adequately represented by adding together the separate radiations of the constituents of the mantle. The opposite supposition, that the light is due to phosphorescence, requires that the greater part of the effect should arise only when the constituents are present together. This result seems to be in conflict with the new experimental data.

ZOOLOGICAL.

By R. LYDEKKER.

The Intestinal Appendages of Birds and Mammals

AN important contribution to our knowledge of the intestinal anatomy of mammals has just been published in the *Transactions* of the Zoological Society, Dr. Chalmers Mitchell, the Society's secretary, being the author. Perhaps the most generally interesting feature in this memoir is the identification of the paired "cæca," or blind appendages of the intestine, of birds with the, usually, single cæcum of mammals. These cæca occur at the junction of the small with the large intestine; and while in ordinary perching birds they are reduced to small nipple-like buds of no functional importance, in many other birds—owls for instance—they form quite long receptacles. Among mammals, the horse and the dog may

be cited as instances where the single cæcum is of large size, this being especially the case in the former, where it is of enormous dimensions; in human beings, on the other hand, the cæcum is rudimentary, and best known in connection with "appendicitis."

The existence of paired cæca was previously known in a few armadillos and ant-eaters, but Dr. Mitchell has now shown that they are quite common in these groups, while he has also recorded their occurrence in the hyrax and the manati. With the aid of these instances of paired cæca, coupled with the frequent existence of a rudiment of its missing fellow when only one is functional, the author has been enabled to demonstrate conclusively that these double organs in birds correspond in relations with their normally single representative in mammals.

Teeth of Early Carnivora.

Much difference of opinion has obtained among naturalists with regard to the affinities of certain extinct carnivorous mammals from the Tertiary strata of South America, some authorities regarding them as more akin to the predaceous marsupials, while by others their relationships are believed to be closer with the primitive European and North American Carnivora known as creodonts. This opens up the wider question as to the existence of a direct relationship between creodonts and marsupials. On this difficult question considerable light has been thrown by investigations into the structure of the enamel of the teeth of the two groups, the results of which were recently communicated by Mr. Tomes to the Zoological Society. According to the author, marsupial teeth show in the structure of their enamel a well-marked peculiarity, namely, the free penetration of the enamel by tubes continuous with those of the dentine; while recent Carnivora, the descendants, more or less direct, of the creodonts, also present a disposition of the prisms of their enamel somewhat unusual amongst mammals. Teeth of *Hyænodon* and other extinct genera were examined, and in none of them were marsupial characters observed. On the contrary, in most cases characteristic carnivorous patterns were found, so that in Oligocene and Eocene times the enamel of the ancestral Carnivora had already attained the full specialisation characteristic of the modern group.

Weights of Whales and Dinosaurs.

With characteristic boldness and originality American investigators have recently been making the attempt to estimate the approximate "live-weights" of the huge dinosaurian reptiles of the Oolites, such as *Diplodocus* and *Brontosaurus*. Although at first sight the attempt might appear almost hopeless, their method of going to work has been so thorough and well thought out that there appears to be considerable probability of the estimates at which they have arrived presenting a fair approximation to the reality. The plan adopted was to make a model of the entire reptile, as deduced from a careful study of the skeleton, on a scale of one-sixteenth the natural size. The cubic contents of such a model multiplied by the cube of 16 would indicate the probable amount of water displaced by the reptile when in the flesh. To arrive at this result, one of the miniature models of *Brontosaurus* (the length of whose skeleton is 66½ feet) was cut into six pieces of convenient size for purposes of manipulation; and the equivalent water-displacement of each of these fragments determined with great accuracy in the laboratory. From this the water-displacement of a model of the natural size was calculated by means of the above-mentioned formula, which gave as a result the displacement of 34¼ tons by the entire animal. Since, however, *Brontosaurus* is believed to have walked along the bottom of the ancient lakes in search of food to depths which would cause its whole body to have been submerged, it is probable that the reptile in life was slightly heavier than water, and to allow for this an addition of about ten per cent. was made to the calculated weight, thus bringing the final estimate to a total of 38 tons. Vast as is this weight, it is, however, only about two-thirds of the estimated weight of the heaviest whales, which is presumed to be not less than 60 tons. Further information with regard to this latter estimate appears desirable, and it would be interesting to know which of the larger species is really the heaviest. The Greenland right whale would, from its great bulk, of course weigh well; but as the maximum length of this species was estimated by Sir William Flower at from 45 to 50 feet, while the male sperm-whale is known to measure from 55 to 60 feet, it is possible that the latter monster would scale heavier than the former. On the other hand, despite its length of from 80 to 85 feet, the huge Sibbald's rorqual, on account of its "clipper-built" form, would probably weigh less than either the Greenland whale or the sperm-whale. Any estimates of the weights of whales based on trustworthy data would be of much interest.

It may be added that the weight of the African elephant "Jumbo" was only 6½ tons, and although some individuals of the species may perhaps be somewhat heavier, it is clear that elephants are not in the running in comparison with the American estimate of the weights of dinosaurs.

The Flight of Flying-Fishes.

In the course of a memoir on fossil flying-fishes, published in the Year-Book of the Austrian Geological Survey, Dr. O. Abel reviews the much-discussed question as to whether the existing representatives of such fishes—which belong to two distinct groups, the flying-herrings, or true flying-fishes, and the flying-gurnards—really use their "wings" after the manner of bats, or whether such wings merely serve the same purpose as the flying-membrane or parachute of the flying-squirrels. In the case of both flying-herrings and flying-gurnards, the author denies that the wings are ever used as instruments of active flight. As regards the former, Dr. Abel's opinion agrees with that of the majority of competent observers. In regard to the flying-gurnards it has, however, been stated in the "Cambridge Natural History" that these fishes differ from the members of the former group in that the wings are moved rapidly during the course through the air, thus producing a mode of flight recalling that of many grasshoppers. This assertion is, however, controverted by Dr. Abel, who urges that such movements as take place in the wings of flying-gurnards are similar in their nature to the vibrations which are admitted to occur in those of the flying-herrings or true flying-fishes. The author's statement of the whole case is summarised as follows:—

"It may be taken as certain that the initial impetus by means of which flying-fishes of both kinds launch themselves is due to powerful screw-like movements of the tail-fin. The wings are in no sense propelling organs, but act simply as parachutes."

In striking contrast to this conclusion is one arrived at by an author in the January number of the *Annals and Magazine of Natural History*. According to this, the aëroplane theory, as the above may be called, is an absolute mechanical impossibility, and the flight of flying-fishes is due to incessant and extremely rapid movements of their wing-like fins.

A Male Fish-Nurse.

It has long been known that the males of the strange-looking pipe-fishes take charge of the eggs as soon as they leave the bodies of the female parents, and nurse them in a special pouch on the under side of their own bodies; but it appears to have been reserved for an American naturalist to observe the actual manner in which the transfer of the eggs takes place. From his account, it seems that the male and female fishes entwine their bodies in the form of a double letter S, and that in this position the eggs are passed from the mother to the pouch of the male. As might have been expected, all the eggs are not transferred at once. After the first transference all the eggs of this batch are in the upper part of the pouch, where no more can be received until these are shaken down into the lower end. "To bring this about," writes the narrator, "the male performs some very curious movements. He stands nearly vertically, and, resting his caudal fin and a small part of the tail on the floor of the aquarium, bends backward and forward, and twists his body spirally from above downward. This is repeated until the eggs have been moved into the posterior end of the pouch." These processes are repeated until the pouch is filled. In about ten days the young pipe-fishes are hatched.

Papers Read.

At the meeting of the Zoological Society held on January 16, Mr. O. Thomas exhibited skulls of a forest-pig from the Cameroons district, which he referred to a new species, under the name of *Hylochærus rienater*. Mr. W. S. Fox read a paper on bones of the lynx from a Derbyshire cave; Mr. C. S. Tomes discussed the structure of the enamel of the teeth in Carnivora and marsupials; Mr. F. E. Beddard described the results of investigations into the anatomy of snakes; and Dr. J. Roux contributed a list of the species of a particular group of toads.

XUM

MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Elementary Photo-micrography.

(*Continued from page* 362.)

The utmost care must be taken in observing whether this disc of light is really uniform; it is somewhat deceptive, and a slight re-adjustment may sometimes make all the difference, but if it be not uniform, the photograph will show unequal illumination, that is, one side will be rather darker than the other, which is not satisfactory, though too often seen. The sub-stage condenser and even the auxiliary condenser may need slight re-adjustment and re-focussing to obtain the best results, but any great alteration will not be found satisfactory. A little patient experimenting, however, will be found to teach more than many pages of suggestions.

The advantage of the optical bench or of the parallel slides is now evident, and if there is any change of objective a slight re-adjustment of the condenser is all that is necessary. It saves much labour if everything is left in place, except the microscope, and the position of the latter is carefully marked, or stops made for its stand, but if the auxiliary condenser and illuminant must be removed, then some means should be adopted of so arranging or marking them that they can be, without difficulty, brought back exactly to their previous position when required.

So far, we have done all our focussing upon a piece of ground glass, but this, however fine it may be, will be found too coarse for the final focussing. We must, therefore, have a further frame of plain glass, fitting into the same slides, and once again I must insist on the importance of having the inner surface of this in exact correspondence with the sensitive film of the photographic plate when in its dark slide and in position. It is not a bad plan to fasten a thin circular cover-glass with Canada balsam, in the very centre of the inner and rough side of the ground-glass screen. This makes a little transparent disc for examining the photograph, but it is scarcely big enough to be an efficient substitute for the complete plain-glass screen. In using the latter we have, of course, no surface to form an image upon, and we therefore need a focussing lens of some sort. This may be of the simplest form, but its magnification should not be too high and yet its "depth of focus" should not, for manifest reasons, be too great. A dissecting loop in a cardboard or wooden ring will serve, or one of the ordinary tripod magnifiers, but suitable lenses with a ring for adjustment, can be bought for a few shillings at most opticians. An ink mark is made on the inner surface of the plain glass screen, the focussing lens is brought in contact with the other or outer side, and then adjusted so as to focus the ink-mark through the glass. Dr. Bousfield recommends a double convex spectacle lens of about eight inches focal length, which may be mounted in a cardboard or other tube of suitable length to focus such an ink-mark.

(*To be continued.*)

Journal of the Quekett Microscopical Club.

The half-yearly volume of this journal contains a detailed list of 140 species of Foraminifera, collected by Mr. Arthur Garland, from the shore-sand at Bognor, Sussex, with four illustration plates, also an illustrated article on the genitation of the Tsetse fly, by Mr. Walter Wesché. Mr. F. P. Smith contributes a list of all the species of spiders of the *Walckenaëria* group, which have occurred in the British Isles, and a description of a spider found at Yarmouth, which he believes to be a new species of the Erigone group. The Journal, in accordance with the economic policy of the Club, is considerably reduced in size, which is a matter for regret.

Royal Microscopical Society.

The annual meeting was held at 20, Hanover Square on January 7, the President, Dr. D. H. Scott, in the chair. Attention was called to a donation from M. Nachet, a Fellow of the Society, of six micro-daguerrotypes of blood, milk, crystals, &c., set in a frame. They were taken with the electric light by M. Léon Foucault in the year 1844, and are probably the oldest of their kind in existence. The photographs are of undoubted excellence, and will compare favourably with many of later date. There was also a donation of 15 slides of the Oribatidæ from Mr. N. D. F. Pearce, to supplement the collection presented by Mr. Michael. Some excellent photo-micrographs of diatoms and Podura scale were sent for exhibition by Mr. F. A. O'Donohue. The report of the Council and Treasurer's statement for 1905 were read and adopted, and the names of the officers and Council elected for the ensuing year were announced, Dr. D. H. Scott having been elected as President for a third term. The President delivered his annual address, the subject being "The Life and Work of Bernard Renault," illustrated with numerous lantern slides.

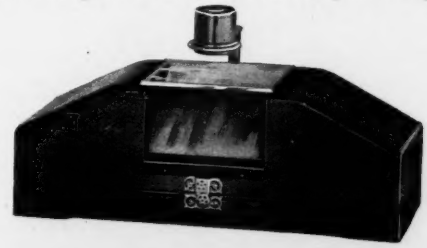
Quekett Microscopical Club.

At the meeting held on January 19 at 20, Hanover Square, Dr. E. J. Spitta in the chair, Mr. R. T. Lewis delivered a lecture on "The Senses of Insects," dealing more especially with sight and hearing. Comparison having been made with the physiology and anatomy of such senses in man, and stress having been laid upon the important part played by psychological factors, the lecturer explained the theory of "Sympathetic Vibrations" and its possible applications. It was suggested that as insects live in the same light and air as man, similar, or, at least, analogous structures should be looked for, but that there was every probability that they were capable of appreciating a far greater range of vibrations of both light and sound, especially in the direction of the shorter wave-lengths. The auditory organs of insects presented a great variety of structure, those of the Orthoptera most nearly complying with what we might expect to find—organs designed to appreciate such sounds, for instance, as we might ourselves hear; but their position and number varied considerably in different families. It was considered that in addition to sight and hearing insects possessed the senses of taste, smell, and touch, and that some were endowed wth the "sense of direction." Mr. Lewis made an interesting statement regarding the figure in Carpenter reputed to be a reproduction of a photograph made by Exner through an insect's compound eye, calling attention to the fact that at a meeting of the Royal

Microscopical Society on November 19, 1890, Professor Bell exhibited a print of the original photograph, which he (the present lecturer) had roughly copied in his note-book, and which showed the letter R the right way round and not reversed as in Carpenter.

Barnes Dissecting Microscope.

Messrs. A. E. Staley and Co. have recently brought to my notice a simple dissecting microscope made by the Bausch and Lomb Optical Co., which is both practical, serviceable, and inexpensive. The body is of neatly finished light wood shaped to form hand rests. The stage is a glass plate, easily removable for cleaning. The mirror is as large as the stage, giving effective illumination. A black or white metal plate can be laid over the mirror when a black or white background is desired. The lens carrier is adjustable for focussing. The base forms a hinged wooden box with receptacles for magnifiers, tweezers, dissecting needles, &c. The whole stand, including an inch doublet lens with large flat field and good definition, costs only half a guinea.



Notes and Queries.

A., Hull.—I have put your query before a gentleman in Cambridge who is an authority on the Carboniferous Rocks, &c., and he considers that Harker would be most suitable for your purpose, but as you say you have this and it is not quite what you want, he suggests that you should endeavour to see Hatch's "Introduction to the Study of Petrology" and "Text-book of Petrology"; Geikie's "Structural and Field Geology," and Rutley's "Study of Rocks," and see if one or more of these will help you. Cole's "Aids to Practical Geology" is also useful. Of course, you will be aware, that the recognition of the constituents of rocks cannot be gained from pictures in books without a preliminary broad and general study of the subject. There seem to be no books dealing exclusively with the special subject in the way you require. I regret the oversight to which you call my attention.

D. B., Manchester.—I think both the books you mention are very suitable for your purpose. Strasburger is perhaps a little better than Bower for anyone working alone and unaided. I think you would find Watson's "Praxis" microscope satisfactory for all kinds of work, and would suggest your obtaining with it $\frac{2}{3}$ and $\frac{1}{6}$ inch objectives (Parachromatic series), the $\frac{2}{3}$ being more generally useful than the $\frac{1}{2}$ inch, and the $\frac{1}{6}$ having a N.A. of ·87, and a No. 2 ocular. This would cost you, with case, £6 10s., but I strongly recommend your adding a "Scop" Abbe Condenser, with iris diaphragm, and an extra No. 4 eyepiece at a total cost of £7 12s. 6d.

C. C. Dobell and C. W. Archer.—I think the "ultra-microscope" to which you refer must be an allusion to Dr. Siedentoff and Dr. Zsigmondy's apparatus for the making visible of "ultra-microscopic particles." You will find an account of this in the "Science Year Book" for 1905, article "Microscopy," page 117, with further remarks in the issue for 1906, page 107; also in the Journal of the Royal Microscopical Society for October, 1903. The principle in brief is the focussing of an arc-light upon a small spectroscopic slit and condenser so as to pass a narrow beam of light at right angles to the optic axis of the microscope upon the particles to be made visible. According to Lord Rayleigh, there is nothing except lack of light to hinder the visibility of any object, however small; but if its dimensions are much less than half a wave-length, its apparent width will be illusory. In other words, the *existence* of the object can be shown if only the light be strong enough, but this will be no guide to its real appearance. It may be of interest to add that, accepting the size of a medium size molecule as $6\mu\mu$, a specific intensity of luminosity considerably exceeding the power of the sun's rays would be necessary to discern such molecules. It is advisable to lay particular stress upon the important difference between the mere making visible of an object and the seeing of it as it really is, as I find many workers with the microscope failing to realise this distinction, and thus entertaining erroneous expectations.

T. H. Russell, Edgbaston.—The only way to find out the magnification of eyepiece and ocular is to measure such magnification, and the easiest way is to project the image of a micrometer at a distance, as explained in Carpenter and other books on the microscope, and to make the necessary simple calculation. If you project the image of the micrometer on a sheet of paper at ten inches from the eye-lens of the ocular you will obtain a similar, if less accurate, result, but the distance *must* be ten inches if it is to correspond pretty closely with the magnification as seen visually through the microscope, because ten inches is the normal visual distance. If your paper is further away the magnification is proportionately greater, and no longer corresponds to that given when you look down the microscope tube. It must be evident that alteration of the tube-length will alter the magnification visually, and in just the same way upon the paper, but the measurement is always taken at ten inches from the tube length because that remains the visual distance of the eye whatever the tube length. Adjust the tube length as you will, you must always measure the *projected* image ten inches away, or, if more, you must reduce the result to what it would be at ten inches. I hope this is quite clear now.

Rev. J. B. Williams, Exminster.—Paraffin of various melting points is used for embedding and infiltrating specimens, one melting at about 50° C. being perhaps the most generally useful in a room temperature of about 16° C. With rocking microtomes a somewhat harder paraffin is better. Hard objects naturally require a harder paraffin than soft ones. Paraffin of various melting points can be readily obtained, but if your paraffin is too hard, you had better mix it with some of a lower melting point, rather than with any other substances. The paraffin in a section can be got rid of by soaking in xylol. Tissues are dehydrated with alcohols of variously graduated strengths, such as 30 per cent., 50 per cent., 75 per cent., and 96 per cent., taking care that sufficient time is allowed in each. Before embedding, the object must be soaked for a considerable time in cedar oil or clove oil. After the paraffin has been got rid of, you can proceed to stain at once in alcoholic stains, but if watery stains are used the object must be first passed back through the alcohols in reverse order, and then before mounting in Canada balsam the dehydration must be gone through again, finishing with a final soaking in xylol, cedar oil, clove oil, &c. The best all-round stains for vegetable tissues are hæmatoxylin, borax carmine (3 per cent. carmine to 4 per cent. borax in 70 per cent. alcohol, a concentrated solution being first made and afterwards diluted with an equal amount of 70 per cent. alcohol), methyl blue, and methyl green. Vegetable tissues must be first hardened for some days in methylated spirit. Cross and Cole's "Modern Microscopy" (4s.) contains very clear instructions for elementary mounting, and my own "Elementary Microscopy" (3s.) has also a chapter on the subject.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for March.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 6.49 and sets at 5.37; on the 31st he rises at 5.41 and sets at 6.28. The Sun enters the sign of Aries at 1 p.m. on the 21st, when Spring commences.

The solar disc continues to be well marked with sunspots, and recent spectroscopic observations of the Sun's limb show many active prominences.

The position of the Sun's axis, equator, and heliographic longitude of the centre of the disc is shown in the following table:—

Date.	Axis inclined from N. point.	C entre of disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
Mar. 2 ..	21° 48′ W	7° 14′	205° 26′
,, 7 ..	22° 59′ W	7° 15′	139° 33′
,, 12 ..	24° 0′ W	7° 12′	73° 38′
,, 17 ..	24° 51′ W	7° 5′	7° 44′
,, 22 ..	25° 32′ W	6° 56′	301° 49′
,, 27 ..	26° 1′ W	6° 43′	235° 54′

The Zodiacal light should be looked for in the west for a few hours after sunset.

THE MOON:—

Date.	Phases.	H. M.
Mar. 3 ..	☽ First Quarter	9 28 a.m.
,, 10 ..	○ Full Moon	8 17 p.m.
,, 17 ..	☾ Last Quarter	11 57 a.m.
,, 24 ..	● New Moon	11 52 p.m.

OCCULTATIONS:—The following are the occultations of the brighter stars visible at Greenwich before midnight.

Date.	Star's Name.	Magnitude.	Disappearance.			Reappearance.		
			Mean Time.	Angle from N. point.	Angle from Vertex.	Mean Time	Angle from N. point.	Angle from Vertex.
			p.m.			p.m.		
Mar. 1	f Tauri	4·3	6.14	121°	101°	7.9	205°	176°
,, 2	γ Tauri	3·9	6.41	116°	99°	7.45	218°	190°
,, 2	θ′ Tauri	3·9	11.51	114°	74°	12.40	235°	198°
,, 6	g Geminorum..	5·1	5.47	15°	51°	6.3	349°	24°

THE PLANETS.—Mercury (Mar. 1, R.A. $23^h\ 16^m$; Dec. S. 5° 56′. Mar. 31, R.A. $1^h\ 0^m$; Dec. N. 10° 1′) is at greatest easterly elongation on the 18th, and should be looked for in the west shortly after sunset for a period of four or five days on either side of the date of elongation. Although the elongation is only 18½°, it is a favourable one on account of the large angle at which the planet sets to the horizon.

Venus (Mar. 1, R.A. $23^h\ 2^m$; Dec. S. 7° 44′. Mar. 31, R.A. $1^h\ 19^m$; Dec. N. 7° 21′) is an evening star in Aquarius, but not well placed for observation. Near the middle of the month the planet sets about half-an-hour after the Sun.

Mars (Mar. 1, R.A. $1^h\ 8^m$; Dec. N. 7° 3′. Mar. 31, R.A. $2^h\ 30^m$; Dec. N. 15° 4′) sets about 9.20 p.m. throughout the month, and may be observed shortly after Sunset looking west. The lustre of the planet is, however, feeble, as he is at a point in his orbit situated at a great distance from the earth.

Jupiter (Mar. 1, R.A. $3^h\ 47^m$; Dec. N. 19° 18′; Mar. 31, R.A. $4^h\ 6^m$; Dec. N. 20° 20′) continues to be a conspicuous object in the evening sky; about the middle of the month the planet sets shortly after midnight. The planet is now describing a direct or westerly path, and thus he appears to be moving away from his position near the Pleiades towards Aldebaran.

The equatorial diameter of the planet on the 15th is 37″·2, whilst the polar diameter is 2″·4 smaller.

The following table gives the satellite phenomena observable before midnight:—

Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s H. M.	Date.	Satellite.	Phenomenon.	P.M.'s. H. M.
Mar				Mar				Mar			
3	I.	Oc. D.	10 58	11	I.	Tr. I.	10 5	20	I.	Sh. E.	9 58
4	I.	Tr. I.	8 7		I.	Sh. I.	11 20	21	I.	Ec. R.	7 16
	I.	Sh. I.	9 25	12	I.	Oc. D.	7 25	22	II.	Oc. D.	8 25
	I.	Tr. E.	10 21		III.	Tr. E.	8 31	23	III.	Ec. R.	7 25
	I.	Sh. E.	11 38		I.	Ec. R.	10 52	24	II.	Sh. E.	8 35
5	III.	Sh. I.	7 24	13	I.	Tr. E.	6 48	27	I.	Tr. I.	8 32
	I.	Ec. R.	8 56		I.	Sh. E.	8 2		I.	Sh. I.	9 40
	III.	Sh. E.	9 31	15	II.	Ec. R.	10 45	28	I.	Ec. R.	9 12
6	II.	Tr. I.	8 45	19	I.	Oc. D.	9 24	30	III.	Ec. D.	9 27
	II.	Sh. I.	11 21		III.	Tr. I.	10 34	31	II.	Sh. I.	8 32
	II.	Tr. E.	11 23	20	I.	Sh. I.	7 44		II.	Tr. E.	9 2
8	II.	Ec. R.	8 9		I.	Tr. E.	8 47				

"Oc. D." denotes the disappearance of the Satellite behind the disc, and "Oc. R." its re-appearance; "Tr. I." the ingress of a transit across the disc, and "Tr. E." its egress; "Sh. I." the ingress of a transit of the shadow across the disc, and "Sh. E." its egress.

Saturn (Mar. 1, R.A. $22^h\ 33^m$; Dec. S. 10° 45′. Mar. 31, R.A. $22^h\ 47^m$; Dec. S. 9° 28′) is a morning Star rising about 6 a.m. near the middle of the month.

Uranus (Mar. 14, R.A. $18^h\ 35^m$; Dec. S. 23° 29′) is not well placed for observation; the planet rises about 3 a.m. on the 15th.

Neptune (Mar. 14, R.A. $6^h\ 33^m$; Dec. N. 22° 18′) is due south at 7.7 p.m. on the 14th. The planet is situated about 3° S. and 1¼° W. of the star ε Geminorum, but is difficult to identify among the numerous small stars in the neighbourhood.

METEOR SHOWERS:—

Date.	Radiant. R.A.	Radiant. Dec.	Near to	Characteristics.
	h. m.			
Mar. 1–4 ..	11 4	+ 4°	τ Leonis	Slow; bright.
,, 14 ..	16 40	+54°	μ Draconis	Swift.
,, 24 ..	10 44	+58°	β Ursæ Maj	Swift.

Minima of Algol occur on the 2nd at 8.7 p.m., 22nd at 9.50 p.m., and 25th at 6.39 p.m.

DOUBLE STARS.—γ Leonis, X.^{h} 15^m, N. 20° 19′, mags. 2, 4; separation 3″·8. In steady air, the prime requisite for double star observations, this double may be well seen in a 3-in. telescope with an eyepiece magnifying about 30 to the inch of aperture, but on most nights one with a power of 40 is better.

The brighter component is of a bright orange tint, whilst the fainter is more yellow.

ι Leonis, XI.^{h} 19^m, N. 11° 5′, mags. 4½, 7½; separation 2″·5. A pretty double of different coloured stars, the brighter being yellow, the other blue. This object requires a favourable night and a fairly high power on small telescopes.

α Leonis (*Regulus*) has a small attendant about 180″ distant, magnitude 8·5, and easily seen in a 3-inch telescope.

α Canum Venat. (*Cor Caroli*), XII.^{h} 52^m, N. 38° 50′, mags. 2·5, 6·5, separation 20″; easy double, can be seen with moderately low powers, even in 2-inch telescopes.